SCIENCE

NEW SERIES. VOLUME XLII

JULY-DECEMBER, 1915

NEW YORK
THE SCIENCE PRESS
1915

THE NEW ERA PRINTING COMPANY,
41 North Queen Street,
Lancaster, Pa.

CONTENTS AND INDEX.

NEW SERIES. VOL. XLII.—JULY TO DECEMBER, 1915.

THE NAMES OF CONTRIBUTORS ARE PRINTED IN SMALL CAPITALS

SCIENCE

FRIDAY, JULY 2, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PRESENT STATUS AND THE FUTURE OF HYGIENE OR PUBLIC HEALTH IN AMERICA[1]

DURING the past few years an increasing and now insistent demand has been heard in this country for better facilities for the training of public health officials. This demand has come from members of the medical profession, chiefly those engaged in official positions as officers or commissioners of health for cities and states, from sanitary engineers, and from various philanthropic societies whose aim is the betterment of social conditions among the poor in our great cities and in our rural communities. With the last this demand is associated with a demand for more enlightened instruction for the general public in matters affecting their health. At this time when these various desires are but an index of the awakening of interest throughout this country in that branch of science known as hygiene or public health, it becomes a matter of vital necessity for those of us who are working in this field to clearly formulate the underlying principles of this science, its scope and its needs, and present them to the public and especially to those who hold the fate of our great institutions of learning in their grasp and under their direction.

HYGIENE IN GERMANY AND AUSTRIA

Despite the fact that an American-born scientist, Count Rumford, of Munich (Benjamin Thompson of Concord and Boston), was the first to inaugurate and carry out a comprehensive movement for

[1] Read at the May, 1915, meeting of the Association of American Physicians.

the betterment of living conditions among the very poor, during the course of which he made a most accurate and painstaking study of the many factors leading to poverty and ill-health and suggested remedies for them, the modern conception of hygiene was given the continent of Europe by Max von Pettenkofer, the first professor of hygiene in Munich and indeed the first professor of hygiene in any German university. A pupil of Liebig and Voit and a well-trained chemist, Pettenkofer first served as professor of chemistry in Munich, but in 1865 transferred his activities to the science of hygiene, a professorship of which was established for him in this Bavarian institution. More than any other man of his time, Pettenkofer saw clearly the prevailing chaos in the facts and theories relating to the science of health and especially in regard to the infectious diseases. At that time epidemic after epidemic of typhoid fever devasted the population of such cities as Munich and Vienna, Asiatic cholera was always knocking at the doors of central Europe and frequently obtained admission, while other zymotic diseases spread like wildfire from person to person when once started in a community. The laws passed to control these epidemics were ineffective and the mortality from disease extremely high. The single exception to the prevailing helplessness was the Jennerian vaccination which had placed small-pox in the sphere of controllable diseases. Pettenkofer not only realized the inadequacy of the methods employed to limit the spread of disease, but he also saw that the fundamental difficulty lay in the ignorance of the medical profession in regard to the mode of transmission of infections from one individual to another. In this great crisis, for such indeed he felt it to be, Pettenkofer raised a powerful voice and demanded that the various facts relating to disease "en masse" should be thoroughly studied by experts just as the symptoms and pathology of individual cases were being studied by experts, that after the fundamental facts had been observed on a broad basis, theories to explain these facts should be formulated and submitted to the rigid test of experiment, to the end that proper conclusions from fact, theory and experiment might be drawn and measures in accord with these conclusions be carried out. In other words, Pettenkofer demanded that the empiricism of hygiene should be converted into a science. To accomplish this he further insisted that departments of hygiene be established in the various universities, that proper equipment be provided to gather the data and test the theories of hygiene, and that trained scientists be given the opportunity of carrying out this work. The wide-spread agitation coming from the movement originated by von Pettenkofer resulted in the establishment of a department of hygiene in the University of Munich, the selection of von Pettenkofer as professor and the construction of a hygienic institute. This institute founded in 1865 still stands, I believe, although plans for a new building upon somewhat more modern lines have now been completed.

From this brief résumé it may be seen that Pettenkofer was really the founder of modern hygiene, at least in so far as the German-speaking races were concerned. He occupies indeed the same position in regard to hygiene that Virchow does in pathology.[2] The radical movement in

[2] An interesting analogy is also evident in the domain of therapeutics. In this science Schmiedeberg, a pupil of Bucheim, who founded the first laboratory for the scientific study of drugs in Dorpat, realized the inadequacy of the existing knowledge of the composition and the action of the various remedies employed by the medical profession largely on an empirical basis. He demanded that the medical profession turn from the clinic to the

hygiene fathered by him made a profound impression upon Europe, especially upon Germany and Austria. Professorships were established in the leading medical schools, first in Bavaria and then in other parts of the German empire, thoroughly trained men were put in charge of the administration of sanitary laws and the attempt made to limit the spread of the infectious diseases by scientific methods. The new knowledge acquired by Pettenkofer and his pupils, and the laws promulgated at their suggestion soon began to have a definite influence upon the mortality returns. In the city of Munich, for instance, the sewage system was reconstructed and proper methods established for drawing off human and animal wastes, a new and pure supply of drinking water was obtained, old, ill-constructed houses were pulled down and air and sunshine admitted to the darkest sections of the city. A special corps of sanitary police was instituted, the members of which were given extraordinary powers so that they could visit every quarter of the city, and enter every dwelling to enforce the execution of the new sanitary laws. As a result of these sweeping changes the mortality from zymotic diseases fell rapidly in Munich and typhoid fever practically disappeared. In Vienna also, where Gruber, a pupil of von Pettenkofer, became professor of hygiene in the university, a similar change took place. Here was a city built within narrow walls, the population crowded together in unsanitary quarters with a water supply from surface wells sunk in a sewage-permeated soil. Sweeping reforms were instituted in this old medieval town, a new method of sewage disposal established, a new water supply obtained and in a surprisingly short time the typhoid mortality was cut in two. Whereas in 1874 it had been 15–16 per thousand, by the end of two years it had fallen to 7–8 per thousand and subsequently steadily diminished.

laboratory, study the chemical composition of drugs, determine their action by animal experimentation and endeavor to explain this action by the facts and theories of physiology. Under the leadership of Schmiedeberg the new science of pharmacology was established to take the place of the older science of therapeutics.

Under the stimulus of von Pettenkofer the new science of hygiene developed rapidly and from his institute in Munich his pupils passed first to one and then to another of the European universities as the chairs of hygiene were founded. Thus Buchner became associated with hygiene in Munich, Gruber went to Vienna, von Fodor to Budapest, Flügge to Göttingen (later to Breslau), Hofman to Leipzig, Lehmann to Würzburg, Rubner to Marburg, Pfeiffer to Rostock and Prausnitz to Gratz. The science of hygiene was established upon a firm basis and it is not too much to say that the movement inaugurated by von Pettenkofer was one of the most important movements in the science of medicine of the nineteenth century.

The Munich school of hygiene was developed in the days before modern bacteriology was dreamed of however, the etiological agents of disease were unknown and much of the work of the great investigators had to be carried out upon a hypothetical basis. This is best shown by the famous x y z hypothesis of von Pettenkofer by means of which he attempted to explain the spread of the diseases in which the intestinal tract is involved, typhoid fever, cholera and dysentery, the so-called diseases of the soil or Bodenkrankheiten. The kernel of this hypothesis lay in von Pettenkofer's belief that the unknown etiological agents of these diseases must undergo a process of modification or ripening in the soil before they are in a condition to produce the disease in other individuals. With the rise of the new science of bacteriology as the result of

the wonderful and brilliant investigations of Robert Koch and his immediate pupils, especially the discovery of the responsible parasites of anthrax, tuberculosis, Asiatic cholera and typhoid fever, the Munich school of hygiene received a staggering blow. Here were the hypothetical etiological agents of disease capable of demonstration under the microscope and of cultivation in the laboratory. Why waste one's time indeed in arguing about an unknown factor when this factor had been discovered and identified and the facts relating to it could be accurately studied? This was especially the case with Asiatic cholera where methods had been devised for the accurate bacteriological examination of suspected cases by the use of which an almost absolute diagnosis could be made in forty-eight hours and the infected individuals quarantined, the simplest possible method of preventing the introduction of this fearful scourge into any community. But the Munich school of hygiene died hard and in the long and somewhat bitter controversy between the old and the new, between Pettenkofer and his pupils and Koch and his, most important facts bearing upon the etiology of the infectious diseases were established. Gradually, however, the newer and more correct theories of the modern bacteriologists supplanted the older and often incorrect theories of the Pettenkofer school and in 1885 Koch became professor of hygiene and bacteriology in the University of Berlin. This set the pace and within the next few years the various professorships of hygiene as they became vacant were filled by the appointment of men trained in the modern bacteriological technique. Thus Gaffky, the discover of the typhoid bacillus, went to Giessen, Loeffler, the co-discoverer with Klebs of the diphtheria bacillus, to Griefswald, Hueppe to Prague, von Behring to Halle and Marburg, Carl Fraenkel to Marburg and Halle and Gärtner to Jena. At the same time hygienic institutes corresponding somewhat to our municipal health laboratories were founded in many of the larger cities of Germany and Austria to provide for the accurate bacteriological diagnosis of the infectious diseases. The largest and best-equipped of such institutes is probably that of Professor Dunbar in Hamburg, one of the few American-born scientists to make his career in Germany. A more recent institute of the same general character is that of the city of Frankfurt a. M. under the able direction of Professor Neisser. With the single exception of the laboratories of the City of New York there are no institutions in America which are founded upon quite the same broad combination of routine work and advanced research as are these.

As a result of the various factors operating to develop the modern science of hygiene in Europe we find that this subject is now firmly established in all the German and Austrian universities. It is a principal or major subject in every medical school and there is an "ordentlich Professor" of hygiene in every university where medicine is taught. Every student of medicine must pass a rigid examination in hygiene before he can obtain his degree and before he can practise his profession. As was to be expected from the somewhat diverse lines of development hygiene has taken we find men of various tendencies occupying the professorships. On the one hand Flügge and Gruber represent the older or Munich school at Berlin and Munich, both trained in the Pettenkofer methods but both greatly influenced in their thought and work by the newer bacteriology of Koch. In Berlin also before the appointment of Professor Flügge, hygiene was brilliantly represented by another product of the Munich

school, Professor Rubner, now professor of physiology. On the other hand, many other chairs of hygiene in Europe are held by the bacteriologists as by Kruse in Königsberg, by Fischer in Kiehl, by Uhlenhuth in Strassburg, by Kolle in Berne, by Schottelius in Freiburg i. B., and by Neumann in Giessen. At the same time hygiene is taught in Vienna by Shattenfroh and Grassberger who clearly unite the two schools, while in Budapest von Lieberman is associated with von Fodor, and may be said to approach the subject more from the standpoint of the physicist.

Despite the great diversity in training of the various hygienists in Germany and Austria, the subjects they teach and study are much the same in the different universities, approached necessarily however from different viewpoints. The fundamental principles of hygiene as applied to vital statistics, heating, lighting, ventilation, clothing, disinfection, sanitation, water and milk supplies, sewage disposal, nutrition and food values are taught to all medical students while special emphasis is laid upon demonstrations which show the mode of transmission of the infectious diseases. Lecture courses in theoretical hygiene are compulsory, laboratory courses in practical hygiene are attended by the majority and all students who are candidates for degrees in medicine must pass a rigid examination in hygiene before graduation. At the same time special courses in hygiene are offered in all the hygienic institutes. They cover a variety of subjects and include such topics as school hygiene, mental hygiene, the hygiene of inheritance, nutrition and systematic instruction in the principles of infection and immunity. Finally elementary bacteriology is taught the medical students in many of the hygienic institutes which in a few instances provide facilities for the cities where the universities are located for diagnostic work in connection with the infectious diseases. No matter how seemingly diverse the subjects or how varied the interests of the many workers in the field, hygiene is a distinct scientific entity in central Europe to-day, the object of whose teaching is the demonstration of all the available facts and theories relating to disease in bulk as distinguished from individual cases of disease.

HYGIENE OR PUBLIC HEALTH IN GREAT BRITAIN

During the period which saw the establishment of hygiene on a modern basis in Germany and Austria, the same science was being developed in England under the name "public health." In Great Britain the system of local control of public affairs had spread more widely than in any of the continental countries in consequence of which the local authorities were enabled to dictate their own mode of government. Local organizations were formed to control all matters relating to the health of the community and the system of local government boards with their peculiar privileges and responsibilities has resulted. This system represents indeed Great Britain's especial contribution to hygiene in the last century and the years 1847 when medical officers of health were first appointed, 1848 when they were required to be qualified medical practitioners (Public Health Act), 1855 when every vestry and district board in London was required to appoint one or more medical officers of health and 1872 when the new Public Health Act forced every sanitary authority outside of London to appoint a medical officer of health, formed the especial landmarks in this chronological development. Long before 1847, however, English physicians had devoted time, energy and thought to the problems of hygiene and the names

dear to the heart of every Anglo-Saxon are scattered over the pages of English medical history. Thus in 1720 Dr. Richard Mead, the physician to St. Thomas Hospital, published his "Short Discourse Concerning Pestilential Contagion, and the Methods to be Used to Prevent It," a book which went through seven editions in its first year of life. In 1764 appeared Dr. John Pringle's work on "Diseases of the Army" which was destined to revolutionize sanitary conditions in jails and hospitals as well as in military camps, while the same service was rendered the navy by Dr. James Lind's publication entitled "On the Means of Preserving the Health of Seamen," soon followed by a series of essays concerning the health of the Royal Navy, on "Fevers and Infection" and on "Jail Distemper." Dr. Gilbert Blane's "Observations on the Diseases of Seamen" appeared in 1785 and in 1796, when Blane was serving as chief officer of the Naval Medical Board under the admiralty, lemon-juice was added to the diet of the seamen and scurvy ceased to rage. Dr. George Baker, in 1767, elucidated the etiology of "colic and palsy" in Devonshire and by his demonstration that this was lead poisoning pure and simple first put the study of industrial diseases upon a scientific foundation. More important than any other single discovery, however, and more beneficial from the world-wide campaign it inaugurated against smallpox stands of course Jenner's discovery of cowpox vaccination in 1798.

In the century from 1738 to 1838 England saw its great rejuvenation manifest in its acute religious revivals, its political emancipation, the social liberation of its lowest classes and the destruction of class privilege, the extinction of slavery, the improvement of agriculture, the extension of trade and commerce and the organization of its industries on a firm basis. During all this time great movements were usually associated with great men and the names of John and Charles Wesley, George Whitfield, Adam Smith, Jeremy Bentham, John Howard and William Wilberforce, will always be held in affectionate reverence by those who are alive to the ills of mankind and who love their fellowmen. By 1838 England had been thoroughly purged of many of its ills and when ten years later the first systematic efforts to regulate the sanitary affairs of London began, the government found a population no longer hostile to sanitary reform. During most of the subsequent period one figure looms up persistently in public health in the United Kingdom, Sir John Simon, who bears much the same relationship to English hygiene that Pettenkofer does to German, and who was fortunately also spared till close to the end of the last century.

As a result of the Public Health Act of 1872, it became apparent that the supply of men trained in sanitary science to occupy positions as public health officers was inadequate and the University of Cambridge set about the task of remedying the difficulty. For this purpose it established the system of examining qualified medical practitioners in the principles of hygiene and granting diplomas to those who satisfactorily passed the examination. In this work the great hygienist Parkes was the leading spirit. The diploma granted came to be known as the D.P.H. or Diploma of Public Health, the holders of such diplomas having a distinct advantage over their competitors when they applied for the coveted positions with the various local government boards. The great advantage to any community in having its medical officer of health a trained sanitarian was soon apparent and in 1892 an act was passed

which required every medical officer of health to have a diploma of public health in every district of 50,000 inhabitants or to have served as health officer before the passage of the act. Thus a medical officer of health in Great Britain is not only a qualified practitioner of medicine but is a trained sanitarian as well.

The example set by Cambridge in granting the D.P.H. was soon followed by other universities in the United Kingdom and at the present time this or a similar degree with the same general purpose is granted in sixteen of the universities in Great Britain as well as by the Conjoint Board of the Royal Colleges of Physicians and Surgeons in England, in Ireland and in Scotland. At the same time the various universities offer courses of instruction in hygiene or public health which qualify men to pass the examinations. In general the work required of a candidate covers nine calendar months, thus corresponding to a year's postgraduate work in America. During this period the candidate spends four months in studying the principles of sanitary science in their application to public health problems, "air, water, soil, sewage, food, climatology, bacteriology, parasitology and the general pathology of diseases of animals transmissible to man, etc." (See Nuttall.) Following this he receives instruction in sanitary engineering, food inspection, epidemiology, occupational hygiene, vital statistics and public health laws. Finally during six of the nine months the student must study public health administration under a qualified medical officer of health and during three months must attend a hospital for infectious diseases and acquire training in diagnosis and in preventive methods. In addition to the men who expect to enter upon an administrative career in public health in Great Britain and who are now required to obtain this diploma, many medical graduates take the D.P.H. as a post-graduate degree corresponding somewhat to our Master of Arts and a large number of the most eminent scientists in the medical profession there are holders of diplomas in public health. Whatever else may be said of the public health instruction in Great Britain and however true some of the criticisms leveled at it may be, it must be admitted that this system has resulted in an enlightened control of sanitary measures by competent authorities which is not surpassed by any other country in the world. How well this system fits into the general political and governmental systems of Great Britain is shown by a glance at their mortality returns in which a death from typhoid fever is so rare as to be an occasion for comment or in a study of the distribution of rabies which seldom or never appears in the British Isles. The English conception of public health differs essentially from the German conception of hygiene, however, and while differences are difficult to formulate, it may be said in general that in England attention is focused upon the administrative side of the subject, while in Germany the emphasis is laid upon the theoretical or purely scientific aspects of the science. This does not mean that in Great Britain the scientific side of public health has been neglected or that in Germany the practical side of hygiene has been forgotten. It is nevertheles true that the modern conception of public health has been furnished the world by Great Britain just as the modern conception of hygiene has been developed in Germany and Austria and that there are certain differences between the two conceptions.

The English notion of public health prevails in Great Britain's colonies and some years ago the late Wyatt Johnston, of

Montreal, established a systematic course of instruction in this branch in McGill University which was the first institution in America to grant a diploma of public health.

HYGIENE OR PUBLIC HEALTH IN FRANCE

In France also from early times thoughtful medical men and government officials were deeply concerned with the health of the people and alive to the necessity of studying and reforming sanitary conditions. On July 6, 1902, Dubois, prefect of police in the City of Paris, founded the Council of Health or Conseil de Salubrité with four members, Deyeux, Parmentier, Huzard and Cadet-Gassicourt. The organization of this body was modified by subsequent decrees in 1810 and in 1815, and similar bodies were formed in Nantes and Bordeaux in 1815, in Lyon in 1822, in Marseilles in 1825, in Lisle (Lille) in 1828, and in Rouen in 1831. In 1848, the year that saw the first Public Health Act of Great Britain, the Conseil d'Etat passed an ordinance for general health regulation throughout France. Since that time the administration of health laws has been on a firm and scientific basis in France and many medical men of prominence like Thouret, Leroux and Dupuytren have been members of the various councils of health. In general the administration of health or sanitary laws is in the hands of the department of police (law, etc.), the Conseil de Salubrité being entirely a consultative body. Its decisions have the practical force of laws however and are seldom reversed. At irregular intervals voluminous reports are issued, relating to health, salubrity and industry. The regulations under the caption Health relate to food and its adulterations, poisonous substances found in it, kind of vessels used in its manufacture, etc. Under Salubrity is considered the regulation of anatomical theaters, barracks for soldiers, public baths, street fountains, water supplies, factories, prisons, markets and disposal of filth. Finally Industry covers the bituminous trades, manufacture of candles, slaughter houses, powder mills, white lead factories, and all places where poisonous gases are liberated. From time to time the old regulations are modified to meet the needs of modern civilization and new regulations promulgated. The wonderful sewerage system of Paris and the beautiful gardens for sewage disposal on the banks of the Seine a few miles below Paris are lasting monuments to the genius of the French hygienists, and the leading positions which French authorities occupy in the scientific development of quarantine testify to their soundness and versatility. French hygiene or public health, however, has been especially influenced in its later development by Pasteur and the various institutes named after him and has, to a considerable extent, developed the idea of preventive medicine. The Pasteur Institute in Paris, originally designed for the study of rabies and the preparation of anti-rabic inoculations, soon took on the character of a general bacteriological and hygienic institute in which the problems of all the infectious diseases were investigated. The other Pasteur Institutes in France and her colonies have also been modeled on the same general plan. Hygiene likewise is an important part of the medical curriculum and a number of standard publications are devoted to it.

HYGIENE OR PUBLIC HEALTH IN AMERICA

When we now turn to the consideration of hygiene or public health in America, it is at once evident that the greatest confusion of ideas prevails concerning the subject. Authorities are not agreed upon

even the fundamental definition of the science the development of which has been both sporadic and limited. It is high time indeed that we should have some sort of free discussion of the whole matter particularly as to the best lines for the future growth of the beginnings already made. Certain fundamental facts stand out clearly. The most important of these is that municipal and state authorities have for years recognized the needs of safeguarding the public health and have established various institutions for this purpose, especially our city and state departments of health. Thus as far back as 1856 our state boards of health were well organized and held an important conference in Philadelphia to deal with the vexing question of yellow fever which appeared at Bay Ridge the previous year. The national government has lagged far behind other countries in public health matters however and a national department of health, so vital to the interests and happiness of every citizen of the United States, has thus far failed of establishment. The abortive attempt made to bring about this much needed reform, in the early eighties, led to the foundation of such a department, which led a precarious existence of only two years. Fortunately the Marine Hospital Service has gradually been able to take up many of the duties of a national department of health and has now become in fact and in name a Public Health Service.

In our universities and in our medical schools, while hygiene was early recognized as a major subject by many of our leaders in medical education, this feeling was by no means widespread. Nevertheless important beginnings were attempted and in some instances splendid results followed. As early as 1865, the year von Pettenkofer became professor of hygiene in Munich, the medical college of the New York Infirmary for women and children made hygiene and public sanitation a compulsory part of its curriculum. Even before this the Women's Medical College of Pennsylvania had taught hygiene in association with physiology. The University of Michigan when its medical department was founded in 1850 taught the principles of the sanitary analysis of drinking water to its students, in the early seventies lectures on hygiene were given to both medical and literary students by the late Dr. Corydon Ford, and in 1876 a course of lectures was given on this subject by the present professor of hygiene there. In 1887 the state legislature made an appropriation for a hygienic laboratory which was formally opened in the session of 1887–88. In Western Reserve, in Cleveland, state medicine and hygiene were taught as early as 1881 sometimes in association with pathology and again in connection with clinical subjects. In Harvard lectures on hygiene were given in 1876, and the present department of preventive medicine was established later as a department of hygiene with the late Dr. Harrington as director. In 1892 the institute of hygiene of the University of Pennsylvania was established upon a broad foundation with the gifted Dr. Billings in charge and in this institute we see most clearly the influence of the Munich school of hygiene upon medical thought in America. Foundations of hygiene were likewise provided for in many other medical schools such as the University of California and Cooper Medical School in San Francisco. With the exception of Michigan, Pennsylvania and Harvard however the hygiene which was taught in America was presented either by practising physicians or by health officers whose time was largely occupied by administrative duties and who gave brief and in general unscientific lectures upon public health topics to medical students. The excellent

example set by three of our leading medical schools was not followed, the science of hygiene failed to develop generally and in many instances the older foundations of hygiene were abandoned to make room for subjects regarded as of greater necessity in the medical curriculum. Thus the department of hygiene in Cooper Medical School, now Leland Stanford, gave way to a department of bacteriology. Recently however Western Reserve has reorganized its work in hygiene and has appointed a full-time professor in this branch, a similar change has taken place in Yale and the relatively new University of Chicago has also established such a department. With all this hygiene as a major subject, with a trained scientist giving up his entire time to teaching its principles and studying its problems, exists in but six of our thirty-eight medical schools to-day. What a pitiful showing this makes in comparison with Germany and Austro-Hungary where all the twenty-two universities where medicine is taught have their hygienic institutes or with Great Britain where every graduate in medicine must follow courses in public health and pass examinations in it. I do not mean that many of our medical schools are not making a determined effort to develop the subject of hygiene or that instruction in it is entirely lacking. Indeed excellent courses in public health are given in both Minnesota and Indiana. In the three larger medical schools in New York City hygiene or public health has now become compulsory. At Johns Hopkins too the faculty has long recognized the necessity of further development along this line and the beginnings small though they are have now been made. I merely wish to point out and emphasize that the science of hygiene, one of the most important parts of a medical curriculum, has never reached the same development as an independent subject which has long been attained in Europe, and which has already been reached in America by the scientific branches of medicine, anatomy, physiology, chemistry, pathology and pharmacology, or by the clinical, surgery, medicine and gynecology and obstetrics.

In the same way and possibly as the result of the same influences, hygiene plays but an unimportant part in our state examinations for licensing practitioners of medicine. In but a few states is there a separate examination in hygiene and in some the subject is not even mentioned. Yet there is probably no field in which medical men need training more than in hygiene and in no line of work will his efforts be more beneficial or more appreciated by the community than in the prevention of the spread of infectious diseases by the application of the sound principles of sanitation. The medical profession of America is neither indifferent to the great problems of preventive medicine nor ignorant of its principles however. The long and honorable career of the American Public Health Association and the more recent development of the Section of Hygiene and Preventive Medicine of the American Medical Association testify to the contrary. The indifference to hygiene as a science lies in our universities and in our medical schools and the responsibility for the failure of its development rests clearly upon them.

PRESENT NEEDS

The question now rises as to the especial needs of hygiene, and the conditions which must be met in order that it shall develop. We may best consider this under three divisions.

There is first a definite need and even a necessity for the training of medical students in the science of health, whether the science be labeled hygiene, public health or

preventive medicine. Every man who graduates from a medical school should be taught, some time during his course, the underlying principles of hygiene. He should know what the word ventilation means, for instance, something about clothing, the kinds of exercise suitable for different individuals, the values of foods, how a good water supply differs from a poor one, what good milk is, how a city should dispose of its sewage. Especially should he be taught the mode of transmission of the infectious diseases and the methods of their prevention. This knowledge the well-trained physician of the future must have, not merely that he may advise his patients properly and safeguard their health, but that he may play his part in the community where he lives and lift his voice on the right side concerning that branch of city and state government which most concerns him, the department of health, too often alas merely a pawn in the hands of unscrupulous individuals to move as they see fit in the great game of politics. To accomplish this purpose, namely, the education of the physician, every medical school in this country should have its department or institute of hygiene in charge of a full-time man with a corps of trained assistants. It makes little difference whether the head of this department is a chemist, a bacteriologist or a physicist, since the problems of hygiene must be approached from various angles, but in the organization of the department provision must be made for teaching the subject with reference to chemistry, bacteriology and physics. Didactic lectures in hygiene must be combined with laboratory exercises and the student must acquire first-hand knowledge of water and milk analysis, disinfection, sanitation, and especially the bacteriological diagnosis and the prophylaxis of the infectious diseases. In addition special courses should be offered in such topics as school hygiene, serum-therapy, nutrition and food valuations, etc. The research side should also play a large part in any department of hygiene. It is not sufficient to teach what we know at present about hygiene. The bounds of our knowledge must be constantly widened, new facts acquired and new theories tested.

The relationship of the department of hygiene to the medical school should also be made clear. It is essential that hygiene be presented as a distinct and independent science and not as a phase of bacteriology, or of chemistry, or of physics. How far the department of hygiene should engage in teaching the elementary principles of the sciences whose methods it uses is also an important question but chiefly as it affects bacteriology. This after all is a matter of merely academic interest. Bacteriology must always be taught medical students from the standpoint of the pathogenic bacteria. If the pathological laboratory has the facilities for teaching bacteriology and the staff have the training there is no reason why general bacteriology should not be taught with pathology. Nor is there any reason why bacteriology should not exist as a separate department in the medical school if funds are available for this purpose. At the same time there is no reason why general bacteriology should not be taught in the hygienic institute so long as it does not encroach upon the teaching of hygiene and provided the head of the department has received the proper training and understands the fundamental principles of infection and immunity. Above all it must be remembered that hygiene is a medical subject and a part of medicine. Its methods are the methods of medicine and have been developed in the medical departments of the European and American universities.

Hygiene must therefore always be taught medical students from the medical point of view by medical men.

The second great need in this country is for better facilities for the training of public health officers. The awakening of the public conscience to the necessity of removing health questions from the domain of politics has resulted in the reorganization of many of our municipal and state departments of health while the excellent achievements of others have given them greater responsibilities and increased facilities for carrying out their work. The system of "county health officers" in which employees of the state department of health are empowered to assume local duties either in cooperation with the local authorities or superseding them has now been adopted in two states and marks a signal advance in health legislation. This is an example indeed likely to be followed by a number of states as time goes on. This change in health administration has created a distinct demand for specialists in public health and the medical departments of our universities must now see to it that the men who take up public health as a career are given the opportunities of fitting themselves properly in the science of hygiene or public health. This can probably best be accomplished by organizing courses leading up to the Diploma of Public Health or some similar degree, the possession of which will guarantee that the holder has received expert instruction which will qualify him to act intelligently as an officer of health. Already three of our best medical schools have organized such courses and other universities are contemplating similar enterprises. It is not enough that this or that school shall establish departments for the training of health officials. This movement is one which vitally concerns the physicians of this country and is likely to have an important influence upon the development of American medicine. The medical profession must demand that our health officers be properly trained, that the Diploma of Public Health shall not be awarded to any sort of individual regardless of his preliminary training to be used merely as a lever to help him to acquire a position. There must be some sort of standardization of the courses leading up to the degree and particularly must there be some agreement as to their length and the amount of time which must be passed in preparation for the examinations. Above all American physicians must remember that the health officer, be he county, city or state, has a distinct function, the intelligent exercise of which requires a medical training. It is not enough that our garbage be disposed of, that our drinking water be chlorinated or filtered, the bacteria in milk be counted or the births and deaths of a community be registered, important as these activities may be. It is far more important that the unsuspected and unreported case of typhoid fever or septic sore throat be ferreted out, the typhoid or diphtheria carrier be recognized, the first case of smallpox be differentiated from chickenpox and that the correct diagnosis of the obscure cases of meningitis or some of the exanthemata be established. It is after all in the great field of the preventable diseases of infectious nature that the health officers will do the most work and bear the heaviest responsibilities. Thus while an engineer or a half-trained medical man who has specialized in public health may satisfactorily perform the functions of a health officer in certain particulars it is difficult to see how he can perform the most important. This is a particularly grave problem in maritime cities where the danger of bubonic plague is constantly increasing or where a case of yellow fever may slip in almost any time. It is an important ques-

tion therefore whether the American medical profession shall permit to develop unchallenged that movement now grown so powerful in this country whereby non-medical men are elevated to positions of authority and responsibility in public health matters, which after all are medical matters. Without doubt many non-medical men may become expert health officers and discharge their duties to the communities which they serve in an intelligent manner. Can they be trusted in a crisis however and are we willing as physicians that a practise so fraught with danger be continued?

Finally how can we educate the great mass of people in this country who are engaging in all sorts of philanthropic enterprises which verge on medicine or which require some medical advice and assistance if all this work is to be prosecuted intelligently. These individuals are constantly turning to the medical profession for the solutions of knotty, difficult problems and indeed in no time in the history of this country have physicians had greater opportunities of directing broad, comprehensive charitable movements in the proper direction so that great sums of money shall be intelligently used for useful and beneficial objects. This education of the people in matters affecting their health can probably best be given in a museum of hygiene where models of all sorts of apparatus, collections of charts and statistical materials can be made available for study, where public lectures can be given on health topics, where experts in various lines can be consulted, where commissions can be formed for the investigation of special problems of public health. Such a museum would become a great center for education in hygiene and public health and prove of incalculable benefit to the community in which it might happen to be located.

The question as to which of these three needs should first be satisfied is not easy to answer and the answer will also vary according to the individual point of view of those of us who study the problems. They are here presented in what seems to me to be the logical arrangement. If possible let us first educate our medical students, then our officers of health, then the public. Should the order be changed however no great harm will result. Should this country be so fortunate as to see schools of hygiene attached to the medical departments of our universities properly endowed and aiming to satisfy all three needs, then indeed shall we be fortunate beyond the wildest dreams of the most enthusiastic student of the subject.

WILLIAM W. FORD

THE JOHNS HOPKINS UNIVERSITY

BIBLIOGRAPHY

Report of the Sanitary Commission of Massachusetts, 1850.

Nuttall, in *Transactions of the Fifteenth International Congress on Hygiene and Demography*, Vol. IV., p. 417, 1913.

Simon, English Sanitary Institutions, London, 1890.

MEASUREMENTS OF THE DISTANCES OF THE STARS[1]

FOR the lecture in honor and memory of Edward Halley, which it is my privilege to deliver this year, I have chosen an account of the persistent efforts made by astronomers to measure the distances of the fixed stars. For many generations their attempts were unsuccessful, though some of them led to great and unexpected discoveries. It is less than eighty years ago that the distances of two or three of the nearest stars were determined with any certainty. The number was added to, slowly at first, but afterwards at a greater rate, and now that large

[1] The "Halley Lecture" (slightly abridged), delivered at Oxford on May 20, by Sir F. W. Dyson, F.R.S., Astronomer Royal, and printed in the issue of *Nature* for June 3.

telescopes are available and photographic methods have been developed, we may expect that in the next few years very rapid progress will be made.

For many centuries astronomers had speculated on the distances of the stars. The Greeks measured the distance of the moon; they knew that the sun and planets were much further away, and placed them correctly in order of distance, guessing that the sun was nearer than Jupiter because it went round the sky in one year while Jupiter took twelve. The stars, from their absolute constancy of relative position, were rightly judged to be still more distant—but how much more they had no means of telling.

In 1543 Copernicus published "De Revolutionibus Orbium Cœlestium," and showed that the remarkable movements of the planets among the stars were much easier to understand on the hypothesis that the earth moved annually round the sun. Galileo's telescope added such cogent arguments that the Copernican system was firmly established. Among other difficulties which were not cleared up at the time one of the most important was this: If the earth describes a great orbit round the sun, its position changes very greatly. The question was rightly asked: Why do not the nearer stars change their positions relatively to the more distant ones? There was only one answer. Because they are so extremely distant. This was a hard saying, and the only reply which Kepler, who was a convinced believer in the earth's movement round the sun, could make to critics was "Bolus erat devorandus."

Although no differences in the positions of the stars were discernible to the naked eye, it might be that smaller differences existed which could be detected by refined astronomical measurements. To the naked eye a change in the angle between neighboring stars not more than the apparent diameter of the sun or moon should be observable. No such changes are perceived. The stars are—it may be concluded—at least two hundred times as distant as the sun. With the instruments in use in the seventeenth century—before the telescope was used for the accurate measurement of angles—angles one twentieth as large were measurable, and the conclusion was reached that the stars were at least four thousand times as distant as the sun. But no positive results were obtained. Attempts followed with the telescope and were equally unsuccessful. Hooke tried to find changes in the position of the star γ Draconis and failed. Flamsteed, Picard and Cassini made extensive observations to detect changes in the position of the pole star and failed. Horrebow thought he had detected slight changes in the position of Sirius due to its nearness in a series of observations made by Römer. He published a pamphlet, entitled "Copernicus triumphans," in 1727, but the changes in the position of Sirius were not verified by other observers, and were due to slight movements of Römer's instruments.

Thus in Halley's time it was fairly well established that the stars were at least 20,000 or 30,000 times as distant as the sun. Halley did not succeed in finding their range, but he made an important discovery which showed that three of the stars were at sensible distances. In 1718 he contributed to the Royal Society a paper entitled "Considerations of the Change of the Latitude of Some of the Principal Bright Stars." While pursuing researches on another subject, he found that the three bright stars—Aldebaran, Sirius and Arcturus—occupied positions among the other stars differing considerably from those assigned to them in the Almagest of Ptolemy. He showed that the possibility of an error

in the transcription of the manuscript could be safely excluded, and that the southward movement of these stars to the extent of 37′, 42′ and 33′—*i. e.*, angles larger than the apparent diameter of the sun in the sky—were established. He remarks:

> What shall we say then? It is scarce possible that the antients could be deceived in so plain a matter, three observers confirming each other. Again these stars being the most conspicuous in heaven are in all probability nearest to the earth, and if they have any particular motion of their own, it is most likely to be perceived in them, which in so long a time as 1800 years may show itself by an alteration of their places, though it be utterly imperceptible in a single century of years.

This is the first good evidence, *i. e.*, evidence which we now know to be true, that the so-called fixed stars are not fixed relatively to one another. It is the first positive proof that the distances of the stars are sensibly less than infinite. This, then, is the stage at which astronomers had arrived less than two hundred years ago. The stars are at least 20,000 or 30,000 times as distant as the sun, but three of the brightest of them are perceived to be not infinitely distant.

The greatest step in the determination of stellar distances was made by another Oxford astronomer, James Bradley. His unparalleled skill as an astronomer was early recognized by Halley, who tells how

> Dr. Pound and his nephew, Mr. Bradley, did, myself being present, in the last opposition of the sun and Mars this way demonstrate the extreme minuteness of the sun's parallax and that it was not more than 12 seconds nor less than 9 seconds.

Translated from astronomical language, the distance of the sun is between 95 and 125 millions of miles. Actually the distance is 93 million miles. The astronomer who so readily measured the distance of the sun entered on the great research which had baffled his predecessors—the distance of the stars.

The theory of the determination of stellar parallax is very simple: the whole difficulty lies in its execution, because the angles are so small that the slightest errors vitiate the results completely. Even at the present time with large telescopes, and mechanism which moves the telescope so that the diurnal movement of the stars is followed and they appear fixed to the observer in the field of the telescope, and with the additional help of photography, the determination of the parallax of a star requires a a good deal of care, and is a matter of great delicacy. But in Bradley's time telescopes were imperfect, and the mechanism for moving them uniformly to follow the diurnal rotation of the stars had not been devised.

This was in some ways very fortunate, as the method Bradley was forced to adopt led to two most important and unexpected discoveries. Every day, owing to the earth's rotation, the stars appear to describe circles in the sky. They reach the highest point when they cross the meridian or vertical plane running north and south. If we leave out all disturbing causes and suppose the earth's axis is quite fixed in direction, a star S, if at a great distance from the earth, will always cross the meridian at the same point S; but, if it is very near, its movement in the small parallactic ellipse will at one period of the year bring it rather north of its mean position and at the opposite period an equal amount south.

Bradley, therefore, designed an instrument for measuring the angular distance from the zenith, at which a certain star, γ Draconis, crossed the meridian. This instrument is called a zenith sector, and is shown in the slide. The direction of the vertical is given by a plumb-line, and he measured from day to day the angular distance of the star from the direction of the vertical. From December, 1725, to March,

1726, the star gradually moved further south; then it remained stationary for a little time; then moved northwards until, by the middle of June, it was in the same position as in December. It continued to move northwards until the beginning of September, then turned again and reached its old position in December. The movement was very regular and evidently not due to any errors in Bradley's observations. But it was most unexpected. The effect of parallax—which Bradley was looking for—would have brought the star furthest south in December, not in March. The times were all three months wrong. Bradley examined other stars, thinking first that this might be due to a movement of the earth's pole. But this would not explain the phenomena. The true explanation, it is said, although I do not know how truly, occurred to Bradley when he was sailing on the Thames, and noticed that the direction of the wind, as indicated by a vane on the mast-head, varied slightly with the course on which the boat was sailing. An account of the observations in the form of a letter from Bradley to Halley is published in the *Philosophical Transactions* for December, 1728:

> When the year was completed, I began to examine and compare my observations, and having pretty well satisfied myself as to the general laws of the *phenomena*, I then endeavored to find out the cause of them. I was already convinced that the apparent motion of the stars was not owing to a nutation of the earth's axis. The next thing that offered itself, was an alteration in the direction of the plumb-line, with which the instrument was constantly rectified; but this upon trial proved insufficient. Then I considered what refraction might do, but here also nothing satisfactory occurred. At last I conjectured that all the *phenomena* hitherto mentioned, proceeded from the progressive motion of light and the earth's annual motion in its orbit. For I perceived that, if light was propagated in time, the apparent place of a fixed object would not be the same when the eye is at rest, as when it is moving in any other direction, than that of the line passing through the eye and the object; and that, when the eye is moving in different directions, the apparent place of the object would be different.

This wonderful discovery of the aberration of light is usually elucidated by the very homely illustration of how an umbrella is held in a shower of rain. Suppose the rain were falling straight down and a man walking round a circular track: he always holds the umbrella a little in front of him—because when he is walking northward the rain appears to come a little from the north, when he is going eastward it appears to come a little from the east, and so on.

Although the phenomena Bradley had observed were almost wholly explained in this way, there were still some residual changes, which took nineteen years to unravel; and he explained these by a nutation or small oscillation of the earth's axis, which took nineteen years to complete its period. I can not dwell on these two great discoveries. For our present purpose, it should be said that aberration and nutation cause far greater changes in the apparent positions of the stars than, we now know, are caused by parallax. Until they were understood and allowed for or eliminated, all search for parallax must have been in vain. Further, Bradley's observations showed that in the case of γ Draconis, at any rate, parallax did not displace the star by so much as 1.0″ from its mean position, or that the star was 200,000 times as distant as the sun. We may say that Bradley reached to just about the inside limit of the distances of the nearer stars.

Let me now try to give some idea of what is meant by a parallax of 1″, which corresponds to a distance 200,000 times that of the sun. Probably many of you have looked at the second star in the tail of the Great Bear, Mizar, it is named, and have seen

there is a fainter star near it, which you can see nicely on a fine night. These stars are 600″ apart; with a big telescope with a magnification of 600 times—and this is about as high a magnification as can be generally used in England—two stars 1″ apart are seen double just as clearly as Alcor and Mizar are seen with the naked eye. I think this is the most useful way to think of 1″—a very small angle, which one needs a magnification of 600 times to see easily and clearly. Bradley showed that γ Draconis did not wander by this amount from its mean position among the stars in consequence of our changing viewpoint.

The next attempt to which I wish to refer is the one made by Sir William Herschel. In a paper communicated by him to the Royal Society in December, 1781, he reviews the serious difficulties involved in determining the parallax of a star by comparing its zenith distance at different times of the year. Especially there is the uncertainty introduced by the refraction of light, and in addition as the angular distances of stars from the zenith are changed by precession, nutation and aberration, any errors in the calculated amount of these changes will all affect the results. He proposed, therefore, to examine with his big telescope the bright stars and see which of them had faint stars near them. The bright stars, he said, are probably much nearer than the faint stars; and if the parallax does not even amount to 1″ the case is by no means desperate. With a large telescope of very great perfection it should be possible to detect changes in the angular distance of two neighboring stars. By this differential method the difficulties inherent in the method of zenith distances will be eliminated. Herschel made a great survey to find suitable stars, and in this way was led to the discovery of double stars—*i. e.*, of pairs of stars which are physically connected and revolve around one another, just like sun and earth. This was a most important discovery, but as the two components of a double star are practically at the same distance from us they do not serve to determine parallax, for which we need one star to serve as a distant mark.

For another forty years persistent efforts were made without success. Piazzi, in Italy, thought he had detected parallax in Sirius and a number of other bright stars, but the changes he detected in the zenith distances were unquestionably due to errors introduced by uncertainty in refraction, or slight changes in the position of his instruments in the course of the year. Dr. Brinkley, in Dublin, made a gallant effort and took the greatest pains. He thought he had succeeded, and for many years there was a controversy between him and Pond as to whether his results were trustworthy. The state of knowledge of the distances of the fixed stars in 1823 is summed up accurately by Pond in the *Philosophical Transactions:*

> The history of annual parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sensible parallax. This has happened in Italy to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the continent; and accordingly it shows a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established, beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion than that this is the reason why it discovers no parallax at all.

Besides these and other efforts to find parallax in the zenith distances of stars, attempts were also made to detect changes in the time at which the stars cross the meridian, to see if they are slightly before their time at one period of the year and slightly after it at another. But these, too,

were unsuccessful, even in the hands of astronomers like Bessel and Struve. The best were some observations of circumpolar stars made by Struve in Dorpat between 1814 and 1821. The following table shows some of the results at which he arrived:

Polaris and ϵ Urs. Maj.	$\pi + 0.053\pi' = +0''.075 \pm 0''.034$
ϵ Urs. Maj. and α Cass.	$\pi + 0.962\pi' = -0.136 \pm 0.110$
ζ Urs. Maj. and δ Cass.	$\pi + 1.099\pi' = +0.175 \pm 0.127$
β Urs. Min. and α Persei	$\pi + 0.402\pi' = +0.305 \pm 0.071$
Capella and β Drac.	$\pi + 1.147\pi' = +0.134 \pm 0.139$
β Aurig. and γ Drac.	$\pi + 1.138\pi' = +0.020 \pm 0.117$

This table has the merit of not looking wildly impossible in the present state of our knowledge. It has the disadvantage of not giving a definite parallax to each star. For example, it is impossible to say how much of the 0.134″ is to be given to Capella and how much to β Draconis. Further, the probable errors, though really small, are nearly as large as the quantities determined.

Struve and Bessel therefore attempted the problem by the differential method recommended by Herschel. By this time it had become easier to carry out. The method of mounting telescopes equatorially had been devised, so that the telescope was always kept pointing to the same part of the sky by clockwork-driven mechanism. Struve chose the bright star α Lyræ, and measured its distance from a faint star about 40″ away on ninety-six nights between November, 1835, and August, 1838. In the focal plane of his telescope he had what is called a position micrometer. The micrometer contains two parallel spider-threads stretched on frames, and the frames are movable by screws until the position shown in the diagram is reached: the distance apart of the threads is known by the readings of the screw-heads. He found that α Lyræ had a parallax 0.262″ with a probable error $\pm$ 0.025″.

Bessel chose the star 61 Cygni as a likely star to be near the sun, and therefore to have appreciable parallax. 61 Cygni is not nearly so bright as α Lyræ, but has a very great angular movement or proper-motion among the stars. Bessel used an instrument called a heliometer. Like Struve's telescope, it was mounted so that it could be driven by clockwork to point always at the same star. The object-glass of Bessel's telescope was made by the great optician Fraunhofer, with the intention of cutting it in halves. Fraunhofer died before the time came to carry out this delicate operation, but it was successfully accomplished after his death.

Delicate mechanism was provided for turning the glass, and also for moving the two halves, the amount of movement being very accurately measured by screws. Each half gives a perfect image of any object which is examined, but the two images are shifted by an amount equal to the distance one-half of the lens is moved along the other. Thus when a bright star and faint star are looked at, one half of the object-glass can be made to give images S and *s*, and the other half S′ and *s*′. By moving the screw exactly the right amount *s*′ can be made to coincide with S, and the reading of the screw gives a measure of the angular distance between the two stars. Bessel made observations on ninety-eight nights extending from August, 1837, to September, 1838. The table, taken from a report by Main,[2] shows how closely the mean of the observations for each month accords with the supposition that the star has the parallax 0.369″:

[2] *Mem. R. A. S.*, Vol. XII., p. 29.

1837

Mean Date	Observed Disappointment	Effect of Parallax 0″.369
August 23	+ 0″.197	+ 0″.212
September 14	+ 0.100	+ 0.100
October 12	+ 0.040	— 0.057
November 22	— 0.214	— 0.258
December 21	— 0.322	— 0.317

1838

January 14	— 0″.376	— 0″.318
February 5	— 0.223	— 0.266
May 14	+ 0.245	+ 0.238
June 19	+ 0.360	+ 0.332
July 13	+ 0.216	+ 0.332
August 19	+ 0.151	+ 0.227
September 19	+ 0.040	+ 0.073

Simultaneously with these determinations of the distance of α Lyræ and 61 Cygni, the distance of α Centauri, one of the brightest of the southern stars, was found by Henderson from observations of zenith distance made by him at the Cape between April, 1832, and May, 1833. He learned just before the termination of his residence at the Cape that this star had a very large proper-motion. Suspecting a possible parallax, he examined the observations when he had taken up his new office of Astronomer Royal for Scotland, and found a parallax amounting to 0.92″. He did not, however, publish his results until he found that they were confirmed by the right ascensions. In a communication to the Royal Astronomical Society in December, 1838, he states that it is probable that the star has a parallax of 1.0″.

The great and difficult problem which had occupied astronomers for many generations was thus solved for three separate stars in 1838 (see table).

Henderson's observation is interesting because α Centauri is, as far as we yet know, the nearest of all the stars to us. But by far the most valuable of these observations is Bessel's. The heliometer, which he devised, proved itself to be by far the most serviceable instrument for determining stellar parallax until the application of photography for this purpose.

	Parallax	Distance	Modern Observations	
			Parallax	Distance
α Centauri (Henderson)	1.0″	200,000	0.750″	270,000
61 Cygni (Bessel)	0.314	640,000	0.285	700,000
α Lyræ (Struve)	0.262	760,000	0.10	2,000,000

(The unit of distance is that from the earth to the sun.)

The somewhat dramatic manner in which the distances of three stars were determined in the same year, after several centuries of failures, may have led to the hope that the range of many more stars would soon be found. This was not the case, however. Each star had to be measured separately, and involved many nights of observations. The quantities to be measured were so small that they taxed the resources of the best instruments and best observers. In 1843 Peters published the parallaxes of half a dozen stars determined with the vertical circle at Pulkova, but the parallax of only one of these, Polaris, is obtained with much accuracy. With Bessel's heliometer, Schlüter and Wichmann measured the distance of Gr. 1830, the star which had the largest known proper-motion. In the 'sixties, Auwers with the same instrument determined the parallax of several quick-moving stars, and also of the bright star Procyon. With the Bonn heliometer, Krueger in the 'sixties measured the distance of three stars, and Winnecke two more. Other observations were made, amongst others, by Maclear, Otto Struve, Brünnow and Ball; but as these observers had not such suitable instruments, their results were not of the same high standard of value. A generous estimate would place the number of stars the distance of which had been satisfactor-

ily determined before 1880 at not more than twenty.

In the 'eighties, progress became more rapid. Gill, the Astronomer Royal for the Cape, in conjunction with a young American astronomer, Elkin, determined with great accuracy, though with only a small 4-inch heliometer, the distance of nine stars of the southern hemisphere. These stars included α Centauri, and the bright stars Sirius and Canopus. These results were communicated to the Royal Astronomical Society in 1884. The work of Gill and Elkin did not stop there. After some years, a very fine 7-inch heliometer was obtained at the Cape, and with it, between 1888 and 1898, the parallaxes of seventeen stars were determined by Gill and his assistants with very great accuracy. The stars observed at the Cape consisted of the brightest stars of the southern hemisphere, and of the stars with the greatest proper-motions. The results were remarkable. The stars with large proper-motions were nearly always comparatively near—say within one million times the sun's distance. On the other hand, some of the very brightest stars, particularly Canopus, the brightest star in the sky after Sirius, were at vastly greater distances.

Meanwhile Elkin, who had been appointed director of the Yale Observatory in 1884, carried out with a 6-inch heliometer, between the years 1885 and 1892, a determination of the distances of the ten brightest stars of the northern hemisphere. After these were finished the Yale observers, Elkin, Chase and Smith, embarked on the ambitious program of the determination of the distances of 163 stars of the northern hemisphere which show large proper-motion. They have added forty-one southern stars to these, and thirty-five stars of special interest. The results of all these observations were published in 1912. They have not, in most cases, the high accuracy of the Cape observations, but, nevertheless, are of great accuracy, and appear to be free from any considerable systematic error. A third important series of observations was made by Peter with a 6-inch heliometer at Leipzig. These were commenced about 1890, and continued until the death of Professor Peter in 1911. The parallaxes of twenty stars were determined with the same high accuracy as the Cape observations.

Observations with the heliometer require both skill and industry. To secure the needful accuracy measures must be made in four different positions of the instrument, so that possible small systematic errors may be eliminated by reversal. Great care is required in the adjustments of the instrument, particularly in the accurate determination of the scale-value at different temperatures. The possibility of obtaining satisfactory results with less labor was considered by Kapteyn, in view of the successful determination of the parallax of Gr. 34 by Auwers. From 1885 to 1887 he made observations with the transit-circle at Leyden of fifteen stars for the purposes of determining parallax. The observation consisted in observing the time when the star the parallax of which was sought and two or three neighboring stars crossed the meridian. Observations are made at the two most favorable epochs—say every night in March, and every night in September—to determine whether the star has changed its position relatively to its neighbors in the interval. The difficulties are twofold. The purely accidental error of observations of transits is considerable as compared with the small quantity which is sought. Besides this, the star of which the parallax is required is probably brighter than the comparison stars, and special precautions are required to guard against personal errors of the observer.

In questions of this kind the only satisfactory way is to judge by the results. From observations made on fifty nights, values of the parallax are obtained not nearly so accurate as the best heliometer observations, but still of considerable accuracy. Finally, the parallaxes of four of the stars which had been previously determined by measures with a heliometer showed satisfactory agreement.

This method has been employed by Jöst at Heidelberg, very extensively by Flint at the Washburn Observatory of the University of Wisconsin, and is now being tried at the Cape by Vouté, a pupil of Kapteyn's. It appears to me that this method can never give results of the highest accuracy, but that it may be of use in a preliminary search for stars of large parallax. The argument of the facility of the method compared with the heliometer has, however, lost much of its force; for, as I hope to show next, the highest accuracy attainable with the heliometer can be secured much more easily with a photographic telescope.

The application of photography to the determination of stellar parallax was first made by Pritchard in Oxford between 1887 and 1889. He took a large number of photographs and measured on them the angular distance of the star which he was considering from four of its neighbors. In this way he determined the parallax of five stars. He began this work late in life, and it was left for others to develop the photographic method and find what accuracy could be attained with it. At first sight it seems very easy, but experience shows that there are a number of small errors which can creep in and vitiate the results, unless care is taken to avoid them.

It has gradually become clear that with a few simple precautions and contrivances, a greater accuracy can be reached in the determination of parallax by photography and with much less trouble than by any other method. Between 1895 and 1905, several astronomers succeeded in obtaining from a few plates results as accurate as could be obtained from many nights' observations with the heliometer by the most skilled observers. In the last five years a large number of determinations have been made. In 1910 Schlesinger published the parallaxes of twenty-five stars from photographs taken with the 40-inch refractor of the Yerkes Observatory, and in 1911 Russell published the parallaxes of forty stars from photographs taken by Hinks and himself at Cambridge. The opinion expressed by Gill on these observations[3] was that but for the wonderful precision of the Yerkes observations, the Cambridge results would have been regarded as of the highest class. The facility with which the Yerkes results are obtainable is expressed very tersely by Schlesinger:

> The number of stellar parallaxes that can be determined per annum will in the long run be about equal to the number of clear nights available for the work.

With the heliometer at least ten times as much time would have been required. During the last year two further installments of the results of the Yerkes Observatory have been published by Slocum and Mitchell, giving the parallaxes of more than fifty stars. It might be thought that the high accuracy attained by them is largely attributable to the great length of the telescope. From experience at Greenwich, I do not think this is the case, and believe that similar results are obtainable with telescopes of shorter focal length. As several observatories are now occupied with this work, we may expect that the number of stars the distances of which are fairly well known will soon amount to thousands, as

[3] *M. N.*, Vol. LXII., p. 325.

compared with three in 1838, about twenty in 1880, about sixty in 1900, and now perhaps two hundred.

The stars the distances of which have been measured have generally been specially selected on account of their brightness or large proper-motion. Each star has been examined individually. Kapteyn has suggested that instead of examining stars singly in this way, photography gives an opportunity of examining all the stars in a small area of the sky simultaneously, and picking out the near ones. The method has been tried by Kapteyn and others—among them Dr. Rambaut. The idea is very attractive, because it examines the average star and not the bright star or star of larger proper-motion. It is liable, however, to some errors of systematic character, especially as regards stars of different magnitudes. Comparison of the results so obtained with those found otherwise will demonstrate whether these errors can be kept sufficiently small by great care in taking the photographs. Until this is done no opinion can be expressed on the success of this experiment, which is worth careful trial.

The question may be asked, How near must a star be to us for its distance to be measurable? I think we may say ten million times the sun's distance. This corresponds to the small angle 0.02″ for the parallax. If a star's parallax amounts to this, there are, I believe, several observatories where it could be detected with reasonable security, though we shall know more certainly by the comparison of the results of different observations when they accumulate.

You will readily imagine that an accurate knowledge of the distances of many stars will be of great service to astronomy. There are ample data to determine the positions, velocities, luminosities and masses of many stars if only the distances can be found. Thus we know the distance of Sirius, and we are able to say that it is travelling in a certain direction with a velocity of so many miles per second; that it gives out forty-eight times as much light as the sun, but is only two and a half times as massive. The collection and classification of particulars of this kind is certain to give many interesting and perhaps surprising results. But it is not my purpose to deal with this to-night. The task I set before myself in this lecture was to give an idea of the difficulties which astronomers have gradually surmounted, and the extent to which they have succeeded in measuring the distances of the stars.

F. W. DYSON

SCIENTIFIC NOTES AND NEWS

FIFTY years ago William North Rice was graduated from Wesleyan University, and two years later was elected professor of geology and natural history, a title which was changed to professor of geology in 1884, when the department of biology was established. Professor Rice's services as teacher, administrator and investigator were acknowledged by the conferring on him of the degree of doctor of laws by Wesleyan University at its recent commencement.

DR. VICTOR C. VAUGHAN, professor of hygiene at the University of Michigan and president of the American Medical Association, received the honorary degree of LL.D. at the annual commencement of Jefferson Medical College, Philadelphia, on June 5.

THREE doctorates of science were conferred by the University of Pennsylvania at its commencement exercises on June 16. The recipients and Provost Smith's remarks were as follows: *Robert Andrews Millikan*—Physicist of eminence, editor, whose investigations in electricity, in molecular physics and heat have won for you deserved and well-merited recognition. *Harry Frederick Keller*—Because of your profound knowledge of chemical science,

because of your acknowledged thoroughness in the teaching of the same, because of your happy solution of perplexing and important problems in inorganic and synthetic organic chemistry. *Arthur Newell Talbot*—Master of engineering in its relations to railway, hydraulic and sanitary construction, eminent as a teacher of theoretical and applied mechanics, prolific and respected writer on these subjects.

YALE UNIVERSITY has conferred its doctorate of science on Dr. Ch. Wardell Stiles. In presenting the degree Professor Woolsey said: "Charles Wardell Stiles, zoologist—Five years of foreign study, arduous research and the spur of visible suffering have fitted and impelled Dr. Stiles to attack the obscurities of parasitic disease. Both brutes and men owe him gratitude. He is the discoverer of the American hookworm, that widespread and dreadful scourge of the south. By his investigation and through his propaganda an entire people is being lifted to a higher plane of physical and economic being."

DR. DAVID WHITE, of the U. S. Geological Survey, has been elected a corresponding fellow of the Royal Society of Canada.

THE Osiris prize of $20,000, which the Institute of France gives every three years for the most remarkable work in science, art, letters or industry, was awarded on June 2 jointly to Professors Widal and Chantemesse and Dr. Vincent, of the University of Paris, for their work in the development of anti-typhoid vaccination. As this prize can only be given to Frenchmen, the institute has awarded a special prize to Sir Almroth Wright, for his discovery of this means of protection from typhoid.

TEN Philadelphia surgeons and four nurses sailed from New York on the steamship *St. Louis*, on June 12, for the war zone in France. They will have charge of a floor in the American Ambulance Hospital, and will make an exhaustive study of the treatment of wounded soldiers. The Philadelphia doctors, most of whom are making the trip at their own expense, will have charge of about 200 wounded men. Of the general expenses about $7,000 of the $10,000 needed has been subscribed. The unit will be abroad three months. Dr. J. William White, emeritus professor of surgery at the University of Pennsylvania, is in charge of the party. Besides Dr. White, the members of the party on the *St. Louis* are Dr. James P. Hutchinson, who will be the managing head of the unit; Dr. Daniel J. McCarthy, neurologist; Dr. Edmund B. Piper; Dr. Walter Estell Lee; Dr. Arthur E. Billings; Dr. Peter M. Keating; Dr. Samuel Goldschmidt, bacteriologist; Dr. Thomas C. Aller and Dr. David M. Davis, of Johns Hopkins University.

DR. CLIFFORD RICHARDSON, of New York, was elected president of the Association of Harvard Chemists at the fourth annual dinner, held recently, at Young's Hotel, Boston. Other officers are: *Vice-presidents*, Professor W. D. Bancroft, of Cornell University, and Dr. F. W. Clark, of Washington; *Secretary and Treasurer,* Professor S. B. Forbes. About thirty-five members were present with these speakers: Professors T. W. Richards and G. P. Baxter, of Harvard University, and George B. Leighton, of Boston.

MR. N. G. NELSON, of the department of anthropology of the American Museum of Natural History, is engaged in excavating the prehistoric and early historic ruined villages in the neighborhood of Santa Fé. Dr. Robert H. Lowie has left for field work among the Kiowa Indians of Oklahoma, the Hopi of Arizona and the Painte of Nevada.

GEORGE B. ROORBACH, instructor of geography in the Wharton School, University of Pennsylvania, has received an appointment from the Carnegie Endowment for the Advancement of International Peace to carry on investigations this summer in Venezuela on the effect of the war on industrial, commercial and financial conditions in that country. Mr. Roorbach sailed for Venezuela June 16, to be gone during the vacation.

MR. FRANK COLLINS BAKER has resigned his position as acting director and curator of the Chicago Academy of Sciences. Mr. Baker has held the office of curator for twenty-one years, during which time he has built up large study collections, many of which have formed the basis for extensive monographs. The

unique natural history survey of the Chicago area, first organized by Dr. W. K. Higby (now deceased), who for many years was secretary of the academy, was largely carried on by Mr. Baker; the educational installations in the museum of the academy were also prepared under his direction. His address for the summer will be 1555 Highland Avenue, Rochester, N. Y.

The Croonian lectures before the Royal College of Physicians of London were announced to be delivered on June 17, 22, 24 and 29, by Surgeon General Sir David Bruce, C.B., F.R.S. The subject of the lectures was "Trypanosomes Causing Disease in Man and Domestic Animals in Central Africa."

Dr. Shipley, master of Christ's College, Cambridge, gave a lecture for the National Health Society, on flies, lice and minor horrors of war, at the house of the Royal Society of Medicine, on June 16.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Barton A. Hepburn, of New York, is to present to Middlebury College a men's dormitory costing nearly $200,000. Mr. Hepburn received his degree of A.B. at Middlebury. The building, on which work is to be started at once, will be five stories of marble or granite, in keeping with the other college buildings.

The Massachusetts Agricultural College has recently received $4,000 by the will of Major Henry E. Alvord, formerly chief of the dairy division of the Department of Agriculture.

The late Dr. W. Aldis Wright, vice-master of Trinity College, has bequeathed the sum of £5,000 for the use of the library of the University of Cambridge.

Dr. Ruby Cunningham has been appointed instructor in hygiene and an infirmary physician in the infirmary of the University of California.

Raymond B. Robbins, Ph.D., has been appointed instructor in mathematics in the Sheffield Scientific School, Yale University.

At Western Reserve University new appointments have been made as follows: Arthur Dunn Pitcher, Ph.D., professor of mathematics; Jesse E. Hyde, A.M., associate professor of geology; John M. Stetson, Ph.D., instructor in mathematics; William Henry Weston, Jr., A.M., instructor in biology.

DISCUSSION AND CORRESPONDENCE

EDITORIAL SUPERVISION FOR EXPERIMENT STATION PUBLICATIONS

The *Experiment Station Record* for April, 1914, contains a pertinent plea for the need of judicious criticism of agricultural experimentation. The following is written in order to direct special attention to this need in experiment-station publications. It is furthermore desired to suggest that the general adoption of certain policies now employed in many of the experiment stations would eliminate from publications such glaring features as poor English and poor literary style, loose and inexact statements, improper use of technical terms, failure to recognize the existence of published works of a similar nature or the bearing of the results secured upon related fields of science, drawing conclusions not warranted by the data in hand, and the publication of superficial or inconclusive work. One needs only to consult the recent publications in order to convince himself that all of these offences have been committed and it is logical to suppose that they will continue to be committed unless measures for their prevention are put into operation.

The following quotations, taken at random from scores of their kind, will suffice to illustrate the need of criticism. "The fungus was run on artificial media," "The appressoria were round, black bodies, from an eighth to a quarter inch in diameter," "Infection experiments were tried with cultures in the open and in the greenhouse," "Infected plants can be distinguished by a thin growth," "They (pycnidia) are hollow within," "No peas have been reported to be attacked by the eel worm out of doors." These statements have been chosen only because of my better famil-

iarity with botanical literature than with other fields of work, and it is not to be presumed that botanists alone among the staffs of experiment stations have offended science and the Queen's English. It is felt that the inclusion, in circulars and bulletins, of statements of this sort is due entirely to a lack of criticism in the preparation of manuscripts. It is perhaps not fully realized that publications are permanent records which are to be regarded as the product of the institution as well as of the author, and that the character of the publication, for which the several officers of the station are jointly responsible, therefore reflects their joint ability.

In order to learn how much editorial and censorial supervision manuscripts receive and to what extent the individual members of the station staffs are actually responsible for the character of the publications, a questionnaire was sent to the director of each of the agricultural experiment stations. Forty-six replies were received. Five of these report that a special officer, known as publicist or editor, censors all manuscripts submitted for publication with respect both to form and to content, and that he, together with the directors, has the power to withhold or to reject any manuscripts submitted. In eighteen of the stations the director alone exercises this censorship. In twenty-three the manuscripts for all bulletins and circulars are submitted to an editorial committee. This committee is variously constituted but in conjunction with the director it exercises all the powers and prerogatives of a board of editors. Certain stations have a standing committee who edit all manuscripts, and others a special committee whose personnel consists of those officers most interested in the particular subject concerning which a publication is desired.

It is realized, of course, that there is a greater complexity of organization in the larger experiment stations than in the smaller. It might be granted too that there is a greater need for the organization of editorial committees in the larger institutions with their greater number of projects for investigation and consequently their greater number of publications. Naturally the officers in the several different departments will be less closely associated with each other and consequently less familiar with the nature of the various problems under investigation in the larger stations.

There are those, not in every station perhaps, who, through lack of ability to express themselves or through lack of training and experience in their own or related fields, would be spared the caustic criticism of their colleagues and of the reading public if their manuscripts had been subjected both to a constructive and to a destructive criticism prior to publication. Too much emphasis can not be placed on the fact that much of the value of a piece of work is lost if it is not carefully written both with respect to syntax and to the employment of such words as convey the author's intended shades and tints of meaning. One does not credit experimentation which is inaccurately reported. It only reflects discredit on the institution, on the author, and on the other members of the station staff. Experiment station publications can not attain the high standard of merit maintained by the scientific journals until a means is provided to secure adequate, critical, editorial supervision of all manuscripts.

FREDERICK A. WOLF
ALABAMA POLYTECHNIC INSTITUTE,
AUBURN, ALA.

A SIMPLE TECHNIQUE FOR THE BACTERIOLOGICAL EXAMINATION OF SHELL EGGS

THE eggs are first immersed in a strong soap solution (the standard soap solution used in water analysis has been found to be very satisfactory) and scrubbed with a small brush to remove any adherent dirt and hen feces; then they are thoroughly dried in a clean towel and immersed in a mercuric chloride solution (1:1,000) and allowed to remain about five minutes.

The egg is now removed from the mercuric chloride solution, care being taken to handle it by the small end, and without drying it is put into 60–70 per cent. alcohol, where it is allowed to remain a few minutes.

Again handling the egg by the small end it is placed upon a three-inch clay triangle (which

has been previously flamed to insure sterility) large end down and the alcohol ignited by quickly passing a flame under the egg. The success of the method from this point on depends upon the formation of a drop of water from the alcohol (60–70 per cent. alcohol has been found most satisfactory) on the bottom (large end) of the egg.

When the alcohol has burned off, a very hot flame (Tirrell burner) is directed at the drop of water on the under side of the egg and after sufficient heating a piece of the egg shell from 1 to 2 cm. in diameter snaps off. In some cases the vitelline membrane is broken at this point and the contents of the egg run out, so it is necessary to have a container ready for use.

If the vitelline membrane does not break at this point or all the contents do not run out, it is only necessary to apply the flame gently to the top (small) end of the egg when the expansion of the air will totally empty the shell. Care must be taken at this point not to burn the egg shell or coagulate the contents. This heating should be done with a nearly luminous flame.

The most satisfactory type of receiver is a large Phillips beaker which has been previously sterilized with a sufficient quantity of broken glass in it to cover the bottom of the flask. This broken glass serves to cut up both the yolk and white and make a homogeneous mixture from which an average sample can be withdrawn and plated, using the usual precautions.

This method has the following advantages:

1. Simplicity. It eliminates the sterilization of instruments in opening the egg and simplifies the operation of breaking the shell.

2. It eliminates the chances of introducing foreign chemicals, which have been used for sterilizing the instruments for breaking the shell, into the egg.

3. It minimizes the chances of infecting the egg during opening and consequently allows of a more accurate determination of the bacterial count of the content.

J. E. RUSH

DEPARTMENT OF BIOLOGY,
CARNEGIE INSTITUTE OF TECHNOLOGY

QUOTATIONS

THE DISMISSAL OF PROFESSOR NEARING

THE issue which the trustees of the university of Pennsylvania have raised by their summary action in dispensing with the services of one of the most able and efficient professors of the Wharton School faculty is vastly more important than any considerations whatever affecting the personality or opinions of the teacher in question or of the members of the board itself. It is because the incident reveals the existence of an irrepressible conflict between two widely differing ideals of university responsibility and duties that it has called forth an instant and widespread protest. The *New Republic* recently defined this conflict as one "between political reaction and political progress, between intellectual repression and freedom of speech, between a plutocracy strongly intrenched and a democracy not yet fully conscious of itself." And the arguments that have been already volunteered in defense of the trustees, albeit they are themselves silent as to the reasons for their unusual action, fully justify the assumption expressed in every protest that the trustees ("the people who raise the money") regard "the expression of economic discontent as immoral," and are determined to penalize instead of encourage, on the part of the teaching staff, that "continual and fearless sifting and winnowing by which alone the truth can be found.

One of the trustees, however, has modified the issue, if he has not raised an entirely new one, when he denied the right of the public or the alumni to demand any explanation of the governing body of the university. "No one has the right to question us" he is reported to have said. "The University of Pennsylvania is not a public institution. It is only quasi-public. We are answerable only to our own sense of duty and responsibility." This is true only in the most narrow and technical sense, and it is certainly not the position taken by the trustees when they approach the city and state for legislative favors and for grants

in aid from the public treasury. But even were it literally true, the public would still have a right to know something about the policy of a great institution, chartered by the state, which performs so vitally important a function in the formation of public opinion and in the creation of an intelligent understanding among the people of the problems of science and government. They have the right to inquire as to motives and actions of those who presume to limit the boundaries of research, to define what is and what is not truth, and to put the brand of uniformity upon the teaching body.

There is something peculiarly Prussian in the assumption that because Mr. A., representing great corporation interests, and Mr. B., appointed to the board by reason of his wealth and his willingness to invest it in university buildings and endowments, have thereby acquired a vested right to design and apply their own peculiar brand of orthodoxy to the teaching of an institution which proclaims in its motto that "culture without character is vain." What sort of "character" will be imposed upon the student body by teachers compelled under threat of summary dismissal to take an oath of conformity to the views of men who can not bear to hear a frank discussion of political, social or economic reform? The public has every right to know whether its greatest teaching institution is free to seek the truth and to proclaim it without fear, or whether it is compelled to suppress every opinion on economics or politics that is for the moment distasteful to trustees whose sole responsibility is discharged when they appoint able and fearless men to its faculties and attend to the business details of university management.—The Philadelphia *Public Ledger.*

SCIENTIFIC BOOKS

Nature and Science on the Pacific Coast. A Guidebook for Scientific Travelers in the West. Edited under the auspices of the Pacific Coast Committee of the American Association for the Advancement of Science. Paul Elder & Co., San Francisco. 1915.

This is a happily conceived and creditably executed enterprise by the Pacific Coast Committee of the American Association for the Advancement of Science. Its many chapters, individually and severally, are chart and compass to the natural attractions and scientific wealth of the west coast and will make an effective guide to the traveler of this and future years. All the world is on the way to the Fair, and it is certainly appropriate that the organized body of scientific men of the west have joined hands in preparing this useful and attractive exposition of what that part of the country is prepared to and does contribute to the scientific treasury of the world.

Probably the old-time breed of eastern folk who entertained the notion that the Pacific ocean washes the western foot of the Alleghany Mountains is now pretty nearly extinct, but there is still something of this psychological attitude in the east toward the west which needs the infusion of just such a serum as a book of this kind, presented in inviting form and popular dress, may produce. Dwellers in Manhattan say they can identify a Brooklynite by his psychology; likewise the dwellers in the east have been wont to look upon the great propositions of the west as not seriously entering into their lives. This is merely by way of expressing an inherited mental attitude. Tides and winds, ocean currents and climate zones, different fauna and other flora, newer mountains, younger rocks, unlike opportunities for economic development, and dissimilar production, all certainly do tend to make the Pacific states unlike, in natural factors and product, to those of the east. As woman can not be expressed in terms of man, so the west can never become fully comprehensible in terms of the east; but the readjustments in ideals and idolatry which invasion of the west by the east requires, are essential to the making of the full-fledged American.

So the present occasion affords every excuse for such an authorized production of these chapters on the natural aspect of the Pacific coast, all of them prepared by men

whose names and activities are familiar and impressive. The worth of the chapters can in no wise be measured by the fugitive character of the occasion that has brought them into existence. The fairs will soon be over and we may hope that before long the great world will again be opened to the traveler, but the scientific men of the west have erected a monument here which will serve not alone as a present guide to the coast but will retain its worth even while its own trees of knowledge continue to bear more fruit.

The scope of the book is rather extraordinary. Dedicated to the late John Muir, it seems, as one might say, to cover every theme into which that genius of the west came into active contact. The chapters begin with a historical approach to the country, touching upon the Spanish occupation; then passing through the meteorology and physiography, reach the solid foundations in a series of important essays on the geological features. The foundations being thus laid, biological chapters follow, the flora and fauna of land and sea being taken up, each after its kind; then ethnology and the skies which bend themselves about the Pacific coast to give it its cosmic individuality. In the sequence come the practical applications of these scientific factors, in agriculture, in irrigation, in chemistry; much on the out-of-doors, something on the literature, a little on the special mode of juridical and political development, and, in fine, a chapter on things to see and how to see them.

The chapters of this book can, of course, be referred to only in the briefest way in a notice of this kind, but it may be said that the text throughout is supplemented with effective half tones and useful maps, 29 of the former and 14 of the latter, in addition to which is a considerable number of text diagrams and sketches. The maps are, for the most part, of the greater cities and their vicinity, but there are double-sheet maps, one of the geology of the west coast and one of the life zones of California.

I. *The Approaches to the Pacific Coast. By Frederick J. Teggart.*—The early outpourings of Asia; the advance of Spain from the victorious armies of Cortes at the south; the individual initiative of the English explorer coming through from the north; the persistent endurance and final triumph of generations of frontiersmen pressing overland in defiance of natural barriers, constitute a romantic adventure in settlement which, somehow, seems to laugh at "gateways" and "geographic control" and to trifle with some of the most sacred dogmas of "human geography."

II. *Spanish Settlements on the Pacific Coast. By Charles E. Chapman.*—A valuable record of the Spanish occupation and of the Mission Fathers—"California under Spain, beside which Acadia and Utopia were unattractive, a dream life for over half a century." With a map locating the missions, pueblos and presidios of California.

III. *Historical Sketch of the Panama Canal. By Rudolph J. Taussig.*—For the contemporary reader somewhat gorged with recent history of the canal, the early dreams of the "Secret of the Strait" and the birth of the idea of the Canal, "which is almost as old as the discovery of America itself," will present a singular attraction.

IV. *Weather Conditions on the Pacific Coast. By Alexander McAdie.*—Premising that we know little of the causes of "weather" anywhere, the accomplished author of this chapter explains how very much that little is by a series of temperature charts and statistical records of weather variations, sunshine, wind, fog, rainfall, etc. Some interesting statements are found in these paragraphs, interesting at least to those who have become used to the glowing réclamé of California weather. "The amount of sunshine received at San Francisco is not as large as might be expected, but nevertheless compares favorably with that of other cities of the United States." "One of the most marked climatic features of San Francisco is the prevalence of fog. . . . the summer afternoon sea fog shuts out 50 per cent. or more of the possible sunshine between 3 and 7 P.M. during June, July and August." "In addition to the summer after-

noon sea fog moving from west to east and the land or tule fog of winter mornings, there is a third kind of fog which may be called smoke fog. Under certain atmospheric conditions the smoke of the city moves seaward during the forenoon and returns about 1 P.M. as a dense black pall."

V. *Physiographic Geography. By Ruliff S. Holway.*—Outlines the remarkable contrasts in the upstanding geologic expressions of the coast.

VI. *Geology of the West Coast Region of the United States. By C. F. Tolman, Jr.*—A summary of the results of an army of workers in this field; outlining the geologic succession up to the Cordilleran Revolution, giving its history since, a correlation table of the entire rock column, a summary of the mineral production and a *vade mecum* to the principal mining districts of California.

VII. *Earthquakes. By J. C. Branner.*—A succinct statement of seismological principles and factors, covering an actual two and one half out of a possible three hundred and two pages; an obviously inverse proportion. Pneumatologically and strategically the gem of the collection.

VIII. *Mines and Mining. By H. Foster Bain.*

IX. *Petroleum Resources and Industries of the Pacific Coast. By Ralph Arnold.*—Further and more detailed statements of production of the basic minerals with which the west coast enters the market. California, no longer first in gold production, is now first in the production of petroleum, and perhaps no feature in the development of the mineral industry of America has been so extraordinary as the California output of oil. Notice is taken of the various oil districts and the fundamental relation of oil storage to monocline structures. Referring to the origin of the oils, the following paragraph is an excellent contemporary expression:

"The oils of the California fields are believed to have been derived largely from the organic shales which are associated with the oil-bearing beds in all fields of the state. It is believed that the oil originated from the organic matter, both vegetable and animal, which is contained in these beds. Probably the principal source of the oil has been the diatomaceous deposits which make up a large percentage of the Tejon or Eocene formation in the Coalinga district and the Monterey or Lower Miocene formation throughout the balance of the districts. Other organisms that may also be the source of some of the oil are plants, Foraminifera, Bryozoa and possibly mollusks and fish. A great deal of evidence can be advanced favoring the organic origin of the oil in California and enough demonstrating the impossibility of its inorganic origin locally to practically prove the former theory by the process of elimination."

It seems rather appropriate that, in connection with this very positive expression, the author has inserted in his chapter, on the reverse side of a plate showing the oil derricks in Santa Barbara county, a picture of a group of trilobites and other oleaginous Cambrian crustaceans collected by Mr. Walcott at Mt. Wapta, British Columbia.

X. *Significant Features in the History of Life on the Pacific Coast. By John C. Merriam.*—Paleontologic science on the west coast has had remarkable development in late years, and aside from the well-known discoveries from the older rocks, the life records of the Pleistocene caves and of the asphalt pool of Rancho La Brea are among the amazing things of the earth. Of the latter Doctor Merriam says: "Literally hundreds of thousands of specimens have been obtained from these deposits," and the victims of these tar-traps are of considerably more than 100 species, from saber-toothed tigers to thousand-legged worms. Such a snare as this indicates most impressively what tremendous faunas have roamed the earth and air in past ages and have escaped untrapped.

XI. *The Vertebrate Fauna of the Pacific Coast. By Joseph Grinnell.*

XII. *Fishes of the Pacific Coast. By David Starr Jordan.*—Exceedingly interesting résumés, the latter with much useful data regarding the fisheries production.

XIII. *Marine Biology of the Pacific Coast.*

By Charles Atwood Kofoid.—This presents the invertebrate life, gives some account of the aquaria and research stations along the coast, notes the collecting grounds, takes special note of that characteristic Californian, the Abalone, and of the seals, sea lions and whales of these waters.

XIV. *Oceanic Circulation and Temperature off the Pacific Coast. By George F. McEwen.*—An empirical and theoretical consideration of the causes of present oceanic circulation on the west coast.

XV. *Insects of the Pacific Coast. By Vernon Kellogg.*—A very inviting chapter, as far as it goes, closing with the equivocal remark: "The Pacific coast will match its insects against the equivalent fauna of any other region."

XVI. *Flora of the Pacific Coast. By Harvey Monroe Hall.*

XVII. *Forests of the Pacific Coast. By Willis Linn Jepson.*

XVIII. *The Deserts and Desert Flora of the West. By LeRoy Abrams.*

XIX. *The Marine Flora of the Pacific Coast. By William Albert Setchell.*—A great variety of climatic and soil conditions has given birth to diverse and variable flora, and whether one considers it from the "esthetic, the systematic, the genetic or the ecologic" standpoint, his impressions will be compelling. These chapters present the flora by its geographical provinces and give lists of localities of special botanical interest.

The stories of the Big Tree, "the most remarkable member of the earth's silva," and of its groves; of the coast redwood, "the tallest tree on earth," and of other members of this profuse coniferous flora, are of delightful, if brief, interest.

Into the floral assemblages have been intruded the plants of the desert. As far back as the close of the Cretaceous the Mexican plateau began to grow arid, and here and thereafter "drought resisting plants were taking form." "Here originated the cacti, yuccas, dasylirions" and most of the American desert fauna, and thence they spread north after the glacial period and the increase of arid conditions. The Grand Canyon, the Petrified Forests, the Mohave and Painted Deserts and their floras are considered in Professor Abrams's absorbing chapter, which closes with the assurance that "to come upon any understanding of the strange fascination of this land of little rain . . . one must move out into their open spaces; become a part of their boundless silence; face their trackless sands and bare mountain reaches in the wonderful opalescent light of sunsets and sunrises; gain an insight into the significance of the curious adaptations of plant and animal life, and of the page of earth's physical history laid bare in their reft gorges."

In the account of the marine flora special note is taken of its "chief glory," the kelps; numerous in species, often of enormous size, vastly surpassing those of the Atlantic; their forests, the nests of peculiar fishes, and their commercial possibilities still largely unexploited.

XX. *Burbank's Gardens. By Vernon L. Kellogg.*—Essentially a personal tribute happily without advertising matter.

XXI. *Ethnology of the Pacific Coast. By T. T. Waterman.*—With maps of the southwest and north showing the present location of Indian tribes, the distribution, history and tribal customs of the aborigines are passed in condensed but effective review.

XXII. *Astronomical Observatories. By R. G. Aitkin.*—This is a history of the progress of astronomical observation and of the development of observatories.

XXIII. *Museums of the Pacific Coast. By Barton W. Evermann.*—A brief directory of museums of science, art and history.

XXIV. *Agricultural Development of the Pacific Coast. By E. J. Wickson.*—Beginning with the agriculture of the prehistoric peoples, these activities through the Spanish occupation and into the "American period," the author devotes his chapter largely to enumerating factors fundamental to the future development of agriculture; among them he argues with strong reason the essential superiority of the soils of the arid regions when brought under irrigation.

XXV. *Some Notable Irrigation and Hydro-electrical Developments. By C. E. Grunsky.*—Here the actual achievements of irrigation referred to in the preceding chapter are the subject matter. The projects of the U. S. Reclamation Service and a large number of private undertakings for irrigation and power are taken into account. No irrigation bonds are offered for sale.

XXVI. *Chemical Resources and Industries. By Harry East Miller.*—A review of the chemical industries, based largely on natural mineral and agricultural products.

XXVII. *Mountaineering on the Pacific Coast. By Joseph N. LeConte.*—For the man or woman who accepts no challenge from any upturned angle of the earth, this chapter is a suggestion of things to do.

XXVIII. *Outdoor Life and the Fine Arts. By John Galen Howard.*—A pleasant account of the development of the Forest Theater and Mountain Plays, of the combination of out-of-doors with the drama, to which the western climate has lent the guarantee of success.

XXIX. *Literary Landmarks of the Pacific Coast. By S. S. Seward, Jr.*—Bret Harte, Mark Twain and Stevenson, in passing; Ambrose Bierce (lately discovered by the East), Joaquin Miller, Edwin Markham, Edward Roland Sill, John Muir, Jack London, make a pyramid of "land-marks" of which the capstone is only laid when we add the name of Gelett Burgess.

XXX. *Legal and Political Development of the Pacific Coast States. By Orrin K. McMurray.*—A suggestive account of the development of the legal code from the unformed code of the miners' camps and frontier civilization, a few permanent effects of the Spanish procedure and a brief sketch of the later history of jurisprudence and its controlling conditions.

XXXI. *Scenic Excursions. By A. O. Leuschner.*—A condensed Baedeker of the out-of-doors to a multitude of delectable spots, with the price per spot.

The form of the book, 12mo, makes it handy for the pocket, but as for the paper and typography, these meritorious essays must feel strangely indecorous in their black-and-tan dress of fat, round, gray-black type on yellow paper, most unhappily tiring to the eyes.

John M. Clarke

Catalogue of the Freshwater Fishes of Africa in the British Museum. Vol. III. By G. A. Boulenger. London, 1915.

It was originally intended to complete the account of the freshwater fishes of Africa in three volumes, but so many new species have accumulated during the progress of the work, that a fourth volume has become necessary. The third volume, now issued, is principally concerned with the Cichlidæ, but also includes a number of smaller families. In all, 394 species are described, the great majority also figured. No less than 231 of these species have been first described by Dr. Boulenger, whose labors on African fishes far exceed in magnitude and importance those of any other writer, or perhaps all other writers combined.

The Cichlidæ are of particular interest because of their abundance in Africa and South America, suggesting to some minds a former direct land connection between these continents. In this case we fortunately have positive evidence of a former more northern distribution, a genus of these fishes (*Priscacara*) being found in the Eocene of Wyoming. Boulenger recognizes no less than 41 genera of African Cichlidæ, all distinct from the 26 genera which Eigenmann catalogues for the neotropical region. No less than 21 genera are confined to Lake Tanganyika, so far as the records show. In the large genera *Tilapia* and *Paratilapia* we are told that the scales are "cycloid or ctenoid," but there is some confusion in the use of these terms, owing to the fact that weak and minute ctenoid structures are overlooked, and the scales pass as cycloid, as for example in *Tilapia nilotica.* For a correct understanding of the scale-structure of all these genera, the scales must be removed from the fishes and examined microscopically.

The Cyprinodontidæ or Pœciliidæ present a very different case from that of the Cichlids, having still a northern distribution, and pos-

sessing genera common to Africa and America. The African genera are only six, whereas we have very numerous genera in North America. Three, each with a single species, are exclusive African, one being from Lake Tanganyika (a remarkable form, with ctenoid scales), one from the Cameroon-Niger region (the exposed surface of the scales said to be regularly hexagonal), and one which is really Palæarctic, being found on the northern slope of the Atlas Mountains, in hot springs. The last mentioned, *Tellia,* is like *Cyprinodon,* with the pelvic fins wholly absent. Eighteen species are placed in *Fundulus*—the genus which is persecuted every summer by the biologists at Woods Hole. Forty-two others are referred to *Aplocheilus,* which Dr. Boulenger calls *Haplochilus,* the only distinguishing feature of which appears to be the fact that the dorsal fin is placed more posteriorly. Other characters have been cited by authors, but they apparently break down in dealing with the African fauna. The weakness of *Haplochilus,* as now defined, is indicated by the fact that in 1911 Dr. Boulenger himself described the sexes of a species (*Fundulus gardneri*) as two different things, placing the male in *Fundulus* and the female in *Haplochilus.* Another species, *Haplochilus liberiensis,* certainly seems nearer to *F. gardneri* than the latter is to some other species assigned to *Fundulus.* Thus we have a more or less continuous series, which is divided into two genera principally on grounds of convenience, by a character which in most of the species can be recognized at a glance. The only objection to this arises from the possibility that the arrangement is artificial, and that our American *Haplochilus* have no immediate relationship with those of Asia and Africa. If we use the single character employed by Boulenger, our *Fundulus floripinnis* must be referred to *Haplochilus,* where in fact Cope originally placed it.

Boulenger's "Freshwater Fishes of Africa" is a book which, although strictly technical, ought to find a place in general zoological laboratories, because it serves so well to illustrate the modifications which characterize genera and species. Very rarely can we see such complete series as are represented by the illustrations, and with the relatively scanty materials at our command, we are little able to appreciate the real diversity of animal life.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

A BIBLIOGRAPHY OF FISHES TO BE PUBLISHED

THE time is ripe—and has, indeed, long been ripe—for the publication of a carefully prepared bibliography of fishes, to cover the entire range of the subject: fishes fossil as well as living, and fishes from many points of view, such as anatomy, physiology, embryology, pathology, parasitology, distribution, taxonomy, everything in short excepting matters which deal with clerical details of the fisheries. Such a compilation, it is clear, means much for this branch of zoology; for the literature of the fishes is vast, widely scattered and ill digested. In fact, I believe that there is hardly an investigator to-day who has not been obliged, needlessly, to give weeks or months of his time to searching for references.

The importance of such a bibliography was brought home to me about 1890: at that time I began the work of collecting references to be used in my studies, and as years passed I was able to build up a card-catalogue giving author and subject, which proved indispensable. Later my catalogue became known to correspondents, who in turn found it of use in their studies; and they, for their part, were generous in contributing references, and thus added notably to its value. It next, through the kindness of the Smithsonian Institution, absorbed the bibliography which Professor Goode undertook to publish and which his death left unfinished. Thus the value of the work became greater year by year. About 1910 the American Museum of Natural History allowed me secretarial help in the direction of editing the catalogue for publication. And thereafter, for about a year and a half this secretarial work was carefully carried on under the supervision of my colleague, Dr. Louis Hussakof, and since 1914 by Dr. C. R. Eastman, of the American Museum.

The scope of the undertaking may be understood when one considers that nearly 50,000 references are brought together. These have been gathered from all sources, notably from all accessible bibliographies, serial publications and book catalogues. Finally, the effort was made to complete the lists of titles by bibliographies secured in so far as possible from authors themselves. To this end circulars were sent out to several hundred writers on ichthyology, many of whom responded cordially.

There still remain, however, a number of individual writers who have not contributed the titles of their publications. I have, accordingly, been led to publish the present note in the hope that any who have not already sent to Dr. Eastman or myself their bibliographies may be reminded that we are especially anxious to make the work as complete as possible. And we urge that their lists be sent in without delay, for the work is undergoing its final revision and the first volume is shortly to go to press. This is the "author's" volume which will consist of about 1,000 pages and include under the names of writers a serial list of their publications. The second, or "subject" volume, will be a classified index of the titles in volume I. Here one has access to special papers in the various branches, for example, in anatomy, distribution, embryology.

BASHFORD DEAN
AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK

SPECIAL ARTICLES

THE ACTION OF POTASSIUM CYANIDE WHEN INTRODUCED INTO TISSUES OF A PLANT

IN an issue of SCIENCE last autumn[1] Professor Sanford mentioned some experiments conducted in California in destroying the Australian bug, *Icerya purchasi*, by the use of potassium cyanide placed in the tissues of the tree. Since that issue, a number of articles or notes have appeared from time to time discussing the possibility of the use of potassium cyanide for the destruction of various sucking and wood-boring insects, but no experimental evidence was given as to how the cyanide acted in the tree or why it should kill the insects. During the winter and spring, a few experiments were conducted along these lines. The first work was done on geraniums. A hole was made near the base of the plant and a small piece of potassium cyanide, about half the size of a pea, was placed in the stem. A split piece of rubber tubing was placed around the stem and sealed tight with paraffin to prevent leakage. Twenty-four hours later the plant was examined for the presence of cyanide. The potassium cyanide had disappeared, but the odor of cyanide was present at the wound. Sections of the stem were cut longitudinally and crosswise and tested by the Prussian blue reaction. Thick sections were placed in a 5 per cent. solution of caustic potash for about a minute, then transferred to a solution containing 2½ per cent. of ferrous sulfate and 1 per cent. of ferric chloride, heated to 60° C. After ten minutes, they were placed in a mixture of one part hydrochloric acid to six parts water. When cyanide was present, the sections showed the Prussian blue reaction in from ten to fifteen minutes.

From Mr. Sanford's article, one would expect the reaction to show in the vascular bundles or in the water-conducting tissue of the plant. Such, however, was not the case. Cyanide showed only in the outer cortical layer and in the inner pith cells, the strongest, however, in the cortical layer. The lignified tissue gave no reaction. Positive tests could be obtained for a distance of about one foot above the wound, but only about an inch or an inch and a half below the wound.

Other treated plants were allowed to continue for several days, to study the effects on the plant. It was noticed that whenever the cyanide reached the axle of a leaf, the petiole withered and died within a half-inch of the base, the leaf hanging down from the plant. Similar results were obtained whenever the cyanide reached a succulent offshoot, the cyanide seeming to blister the tissue. Tests for cyanide could not be obtained beyond the injured portion which was at the point of attachment to the stem. The reaction at that

[1] Vol. XL., No. 1032, page 519.

point, however, was stronger than on the main stem, either above or below the branch. Furthermore, it was noticed that in passing out an older lateral branch, the cyanide showed a preference for the upper side of the limb. The question arises, How does the cyanide pass through such a plant? If it passed through the vascular bundles without giving a Prussian blue test, the oxidases in that tissue would have been destroyed, but even in the stems in which a positive test could be obtained, in the cellulose tissue an oxidase test could still be obtained in the vascular bundles by both benzidine and by alpha napthol, although the reaction was not as strong as in the normal plant.

If the cyanide does not pass through the sap, one would naturally assume that it must pass up by diffusion. The facts, however, do not point to such a conclusion. Diffusion should be as rapid or almost as rapid down the stem of the plant as up the stem, which was not the case. On reaching the succulent tissue, one would expect diffusion to be more rapid, but the opposite is true. A histological examination of the tissues of the plant shows the older stems, with large intercellular spaces in the cellulose tissue, particularly in the cortical layer. The young succulent side-shoots have small or no intercellular spaces.

One might conceive of the cyanide passing up through the plant in the form of a gas. Potassium cyanide would very readily be broken up by some of the organic acids in the plant, probably carbonic acid, liberating hydrocyanic acid which could then move up between the cells of the plant without seriously injuring them, except where present in great excess. The cells would absorb some of the hydrocyanic acid, but if the amount be not too great, the cell would oxidize it by its oxidases. Granting its passage as a gas would explain its passage upward faster than downward. It would also explain why, in going out a lateral branch, it travels on the upper side rather than on the lower side and why, on reaching a succulent tissue, with small or no intercellular spaces, it is stopped in its flow. Such tissue with its greater water content would tend to dissolve the hydrocyanic in larger quantities than the cell can withstand, this resulting in the death of the tissue.

A comparative experiment was performed by introducing into the stem of the plant, by means of a siphon tube, a solution of hydrocyanic acid in distilled water. The siphon was arranged so that the pressure was just sufficient to hold the liquid against the tissue. The edges of the tube were sealed to the stem by means of paraffin. This geranium, upon examination in twenty-four hours, showed the hydrocyanic strongest in the vascular bundles rather than in the cellulose tissue. Diffusion also took place downward, as a very strong reaction for cyanide was obtained, as far as the base of the plant, eight inches below the wound. Diffusion downward, however, was stronger through the cellulose tissue than in the conducting tissue. There seemed to be no difference at the side branches—no stoppage of the hydrocyanic in its course as was found where a crystal of potassium cyanide had been introduced. The results of this experiment where the passage was by diffusion and by conduction through the vascular system was quite distinct from where the crystal of potassium cyanide had been introduced. Potassium cyanide was next tried on an apple tree during March, when the weather was still cold. At the end of two days, the limb into which the cyanide had been introduced was cut off and tested for cyanide. The test showed the cyanide only in the woody tissue; in fact, by microscopic examination, it was shown to be only in the lumen of the larger tracheæ. The distance traveled, however, was not more than two inches. Not all the KCN had disappeared from the opening, probably due to the small amount of sap in the tree and the cold weather. It was noticed that a discoloration appeared in the tissue through which the cyanide had passed. This discoloration agreed exactly with the area in which a Prussian blue reaction could be obtained. When the sap increased in the trees, further tests were made. It was found, however, that although potassium cyanide disappeared within two days, April 17–19, the hydrocyanic acid had only traveled

about a foot and a half through the woody portion of the stem. No Prussian blue reaction could be obtained in the bark or in the cambium layer, at any time. Thinking that it might be possible that the cyanide would pass rapidly through the tracheæ and later be destroyed, making a positive cyanide test impossible, a large apple tree was selected for a further experiment. Near the base a hole three quarters of an inch in diameter was bored into the wood. This was plugged up with potassium cyanide, corked and the edges of the cork sealed with collodion. A number of other holes were bored into the tree, one at a distance of a foot above the cyanide opening and four others at varying distances up the tree. These holes were about a half inch in diameter and one and one half to two inches in depth. Rubber stoppers through which were passed glass tubes, sealed at the outer end and containing distilled water, were placed in those holes and the edges sealed with collodion. These were quite comparable to the burrows of a wood-boring insect, and as hydrocyanic is very soluble in water, the water in the tube would dissolve any hydrocyanic passing into these holes. With a negative test in these tubes, the hope of destroying wood-borers extensively through the tree would vanish. The tubes were examined from day to day for the presence of cyanide. Although, by the 22d, all the cyanide had disappeared from the opening, no test could be obtained in any of the tubes, either by precipitation with silver nitrate or by the Prussian blue reaction. On April 29, the tree was examined to determine the path of the hydrocyanic acid. It was found that the hydrocyanic acid had passed through an area varying from an inch to a half inch in diameter, beginning at the upper side of the hole, next to the cork, and had traveled through the woody tissue, missing the first hole containing a tube, by about two inches, continuing up the tree to a height of about seven feet, where the test became weaker and finally negative. The highest opening in the tree, which was at a height of about six and one half feet, was missed by less than a half inch, the course of the hydrocyanic having been interrupted by a knot which it had gone around or otherwise a positive test might have been obtained in this tube.

In the other trees, it was noticed that the hydrocyanic passed through a particular area which had its point of departure on the upper side of the cyanide hole, next to the cork. If the hole drilled in the tree is at right angles to the tree, the hydrocyanic passes up evenly from the upper side of the hole but does not diffuse throughout the wood.

From these experiments, it seems that unless one could collect their wood-borers and have them located definitely in the tree, that treatment would be of little or no value. It might be locally applied where the wood-borer is definitely located, by drilling a hole just beneath it and introducing the potassium cyanide or where the borer has made a large burrow one might successfully introduce the potassium cyanide into the burrow. For the larger number of wood-borers, such as inhabit our oaks—boring in the cambium layer—this treatment would have little or no value, as the hydrocyanic does not travel in the cambium but only through the old tracheæ. For sucking insects, which feed at the vascular bundles, it does not seem that the cyanide could be successfully used. In the light of these experiments, it seems that the Spanish broom upon which Professor Sanford destroyed his Australian bugs, must have a peculiar structure to permit the cyanide to pass through an area reached by the Australian bug. If it is a semi-woody plant, similar to the geranium, it would be conceivable that hydrocyanic acid would pass through the cortical layer and be of some value. To be successful against sucking insects, it would have to pass through the vascular system where the insects feed or between the outer surface and the vascular system. The latter is possible in herbaceous or semi-woody plants but would greatly endanger the life of the plant.

In woody trees, where its path is in the older tracheæ, there seems to be no danger to the tree, as these tracheæ are already dead. Excessive amounts might prove dangerous. It is conceivable that the amount used by Professor

Sanford in his peach tree would act as a stimulant to the tree as in other work upon the effects of fumigating greenhouse plants with hydrocyanic acid evidence has been obtained of stimulation, the results of which will be published later.

WILLIAM MOORE,
A. G. RUGGLES

DIVISION OF ENTOMOLOGY,
MINNESOTA EXPERIMENT STATION,
ST. PAUL, MINN.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION B, PHYSICS

BY combining their interests Section B of the American Association for the Advancement of Science and the American Physical Society always have exceedingly profitable joint meetings; meetings at which nearly all the progressive physicists of the States and of Canada become personally acquainted and from which they return to their respective laboratories taking with them the inspiration of new ideas and the cheer of many friendships.

The recent Philadelphia meeting, at which President Ernest Merritt of the American Physical Society and Vice-president Anthony Zeleny of the American Association for the Advancement of Science alternately presided, was typical of these delightful and helpful occasions.

The address of the retiring vice-president and chairman of Section B, Dr. A. D. Cole, was on "Recent Evidence for the Existence of the Nucleus Atom."

The structure of the atom has been and still is *the* goal of modern physical investigation. Possibly it may never be attained, but the failure to attain it should not be regretted so long as endeavors to this end continue to yield, as heretofore, such valuable incidental discoveries. Dr. Cole's address, published in full in the January 15 issue of SCIENCE, reviews a number of the more recent of these discoveries, and also gives references to many original papers. Both addresses and references will be of great assistance to every physicist who really is interested, whether actively or passively, in that baffling yet enticing subject, the structure of the atom.

The usual symposium consisted, at this meeting, of addresses on "The Use of Dimensional Equations," by Dr. Edgar Buckingham and Dr. A. C. Lunn, followed by discussions by Dr. W. S. Franklin, Dr. A. G. Webster, and others.

Dr. Buckingham's address, following somewhat his paper in the October, 1914, issue of the *Physical Review*, emphasized the practical use of dimensional equations in the logical or mathematical discussion of physical problems.

Dr. Lunn considered the mathematical and metaphysical aspects of the subject, and so interestingly that it is to be hoped that he too will publish in full his contributions to this subject.

The discussion and remarks that followed the principal papers indicated a recognition of the importance of the subject, but also a frank admission that its daily use in the laboratory and the classroom is, perhaps, rather limited.

The sectional committee nominated, and the general committee later elected, Professor Frederick Slate vice-president and chairman of Section B. Professor Slate, however, was unable to serve and a new election therefore was necessary. This was completed at the April meeting of the Council, resulting in the selection of Dr. E. P. Lewis, of the University of California.

At present the officers of Section B are as follows:

Vice-president and Chairman of the Section, E. Percival Lewis, University of California, Berkeley, Cal.

Secretary, William J. Humphreys, Weather Bureau, Washington, D. C.

Member of Council, Gordon F. Hull, Dartmouth College, Hanover, N. H.

Sectional Committee, Vice-president, Philadelphia, Anthony Zeleny; Vice-president, San Francisco and Columbus, E. Percival Lewis;

Secretary, William J. Humphreys, Weather Secretary, Alfred D. Cole; Anthony Zeleny, 1 year; T. C. Mendenhall, 2 years; Dayton C. Miller, 3 years; George W. Stewart, 4 years;

Robert R. Tatnall, 5 years. Ex-officio: Ernest Merritt, President, American Physical Society; Alfred D. Cole, Secretary, American Physical Society.

Member of General Committee, R. A. Millikan, Chicago.

W. J. HUMPHREYS,
Secretary, Section B

NEW ORLEANS MEETING—AMERICAN CHEMICAL SOCIETY

TITLES AND ABSTRACTS OF PAPERS

OPENING address by A. D. Little, "The Industrial Resources and Opportunities of the South."

CHARLES S. ASH: *Contributions of the Chemist to the Wine Industry.*

J. B. F. HERRESHOFF: *Contributions of the Chemist to the Copper Industry.*

E. T. BEDFORD: *Contributions of the Chemist to the Corn Products Industry.*

JAMES LEWIS RAKE: *Contributions of the Chemist to the Asphalt Industry.*

DAVID WESSON: *Contributions of the Chemist to the Cotton-seed Oil Industry.*

G. S. BROWN: *Contributions of the Chemist to the Cement Industry.*

W. D. HORNE: *Contributions of the Chemist to the Sugar Industry.*

SIDNEY MASON: *Contributions of the Chemist to the Incandescent Gas Mantle Industry.*

FRANKLIN W. HOBBS: *Contributions of the Chemist to the Textile Industry.*

H. WALKER WALLACE: *Contributions of the Chemist to the Fertilizer Industry.*

F. E. HAZARD: *Contributions of the Chemist to the Soda Industry.*

WILLIAM H. TEAS: *Contributions of the Chemist to the Leather Industry.*

JOHN A. WESENER and GEORGE L. TELLER: *Contributions of the Chemist to the Flour Industry.*

GASTON D. THEVENOT: *Contributions of the Chemist to the Brewing Industry.*

R. L. BENTLEY: *Contributions of the Chemist to the Preserved Foods Industry.*

WM. P. MASON: *Contributions of the Chemist to the Potable Water Industry.*

R. C. SCHUPPHAUS: *Contributions of the Chemist to the Celluloid and Nitrocellulose Industry.*

A. A. HOUGHTON: *Contributions of the Chemist to the Glass Industry.*

F. L. MOORE: *Contributions of the Chemist to the Pulp and Paper Industry.*

Public address to the people of New Orleans, by Bernhard C. Hesse, "The Chemists' Contribution to the Industrial Development of the United States—A Record of Achievement."

The above papers have been printed in full in the April issue of the *Journal of Industrial and Engineering Chemistry.*

DIVISION OF AGRICULTURE AND FOOD CHEMISTRY

Floyd W. Robinson, *chairman*

Glen F. Mason, *secretary*

E. H. S. BAILEY and W. S. LONG: *On the Composition of the Seeds of Martynia Louisiana (Unicorn or Devil's Claws).*

This plant, which grows wild through the central west and especially in the dry climate of western Kansas, Colorado and New Mexico, has been investigated with reference to utilizing the oil contained in the seed. It has been found that this seed contains over sixty per cent. of a bland oil, 24.21 per cent. of protein and 4.55 per cent. of starch. An examination of the oil shows that it compares favorably with some edible oils, especially cotton-seed oil. The authors suggest that since the plant is so well adapted to a dry climate, experiments should be made to determine whether it may not be profitably cultivated as an oil-bearing plant.

EDWARD GUDEMAN: *Action of Milk on Colloids.*

W. D. BIGELOW and F. F. FITZGERALD: *The Relation of the Refraction, Specific Gravity and Solids in Tomatoes and Tomato Pulp.*

As a result of the examination of a considerable number of fresh and canned tomatoes, and of pulps made up under known conditions, tables have been constructed to facilitate analytical work. The generalizations given below are within the limits of analytical error. The filtrate referred to is obtained by throwing a sample of tomato pulp, or crushed tomato product, on a folded filter. Raw tomatoes should be cooked previously in a reflux condenser. The solids are determined by drying in vacuo at 70° and under atmospheric pressure at the temperature of boiling water.

Solids of pulp in vacuo = solids of pulp at atmospheric pressure × 1.085,

Solids of pulp in vacuo = solids of filtrate in vacuo × 1.125,

Solids of filtrate in vacuo = solids of filtrate at atmospheric pressure × 1.12.

From the specific gravity of the filtered liquid at 20° C., the per cent. of solids of the pulp (not of the filtrate) may be ascertained from the Windish wine table.[1] The figure 0.05 should be de-

[1] Table V., Bull. 107, Bureau of Chem.

ducted from the percentage of solids given in that table.

The solids in the filtrate may be ascertained from the index of refraction, using Wagner's table for beer and wine extract. This table is applicable without correction to the juice of fresh or canned tomatoes. When applying it to the filtrate from pulp of the usual concentration, the figure 0.17 should be deducted from the percentage of solids as given. If the product has been salted, the sodium chloride should be determined and a corresponding correction made in refractive index.

H. S. GRINDLEY, W. J. CARMICHAEL and C. I. NEWLIN: *The Influence of one Feedingstuff upon the Digestibility of Another.*

Eight digestion experiments, each of ten days' duration, were made in which each of three rations—wheat flour middlings alone, wheat flour middlings and ground corn combined in the ratio of 1:1, and ground corn alone—were fed to four pigs. The average results as well as the individual data proved that either wheat flour middlings or ground corn in a ration composed of equal parts of each does influence the digestibility of some of the nutrients of the other feed. It is evident from the results that one feedingstuff does influence the digestibility of another.

G. S. FRAPS: *Chemical Investigations at the Texas Experiment Station.*

The article gives a synopsis of the chemical investigations at the Texas Experiment Station, including the work of the state chemist, the feed control, Adams projects and the Hatch projects. The work deals chiefly with the composition and properties of soils, the composition and values of fertilizers, the adulteration of feeds, the studies of the nutritive values of feeding stuff.

W. J. CARMICHAEL, C. I. NEWLIN and H. S. GRINDLEY: *Individuality of Pigs as to the Completeness with which they Digest their Feed.*

The results of forty digestion experiments, each of ten days' duration, in which each of four rations were fed to four pigs proved that in some instances one animal gave coefficients of digestibility for protein, dry matter, nitrogen-free extract, and ether extract that were always significantly higher than the corresponding coefficients for another animal even in ten tests with four different rations. In a series of experiments, when different rations were used with the same animals, the coefficients, as a whole, for some animals were constantly higher than those for other animals, which showed a consistent relation with reference to individuality.

W. E. TOTTINGHAM: *The Effect of Litters on the Fermentation of Manure.*

Oak shavings, pine shavings and oat straw were incorporated with separate lots of a mixture of fresh horse and cow manures. The changes over a period of twelve weeks were compared with those of a control lot of manure. Dry matter decreased most, by a wide margin, in the straw-littered manure and least in the control. The percentage of the total organic matter soluble in water decreased most in the shavings-littered manures and least in the straw-littered lot. In all the lots the percentage of the total ash soluble in water decreased considerably. The percentage of the total nitrogen soluble in water decreased more in the shavings-littered manures than in the other lots. The percentage of the total nitrogen in the form of ammonia reached its highest value in the control manure. Ammonia production was most sustained in the straw-littered lot. Loss of nitrogen was greatest in the shavings-littered manures and least in the straw-littered lot. Yields of corn and barley in field plot tests have shown only slight superiority of stall manure with straw litter as compared with stall manure with shavings litter.

CHAS. P. FOX: *Bread: Weight of an Akron (Ohio) Loaf.*

W. C. TABER: *Tamarind Syrup.*

The tamarind is a leguminous tree found in tropical and semi-tropical countries. The pulp found in the pod is remarkable for its high acidity, often 12 or 15 per cent., and for its high content of sugar, amounting sometimes to 40 per cent. A syrup prepared from this pulp has come into use in the United States as a summer beverage. After dilution with water, this syrup forms a refreshing acid drink. For the purpose of detecting adulterated tamarind syrups, made largely from tartaric or citric acid and sugar, and colored with caramel, a series of syrups were prepared with known amounts of the pulp. The analytical results obtained are of value in indicating the amount of tamarind fruit used in a syrup.

DAVID KLEIN: *A Survey of the Frozen Egg Industry of Chicago.*

CHARLES L. PARSONS,
Secretary

(*To be continued*)

SCIENCE

Friday, July 9, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

FIRST GET THE FACTS[1]

There is connected with the Department of Commerce a remarkable institution called the Bureau of Standards. Its work is more or less familiar to you because one or more groups of students from this school have visited it at various times. I have on some occasions spoken of this bureau as the "house of accuracy," for in it in a special sense the truth is sought. We call the seeking of this kind of truth research. It may be chemical research or physical research or the act of research applied to any of the sciences that underlie our industries and public utilities. Truth is sought in this work because it is believed that the facts concerning nature are of infinite value to mankind. It is recognized that the effectiveness of our civilization rests upon facts first ascertained and then used. It is there thought faulty to proceed on the basis of incomplete truth or of undigested facts, and neither time, labor, nor expense is spared to find the facts and make them known to those who can use them.

One of the standards of the Bureau of Standards itself must be that of speaking the truth so far as it shall have become known, and men know they may depend upon what it says as expressing the truth within those limits in which it has been ascertained. To tell half of a truth if the other half were known would be thought a destructive violation of the very raison d'être of the service. To know the truth and not to tell it would be equally violative.

In what has been thus far said I have

[1] Address of The Honorable William C. Redfield, Secretary of Commerce, before the Case School of Applied Science, Cleveland, Ohio, May 27, 1915.

described only the normal workings of the scientific mind as applied to research. The mind of science is one of high ideals. It is a modest mind, for it recognizes that there are many things it does not know. It is a discriminating mind, for it tests and selects or rejects as the test may tell. It is a practical mind, for it aims to find the hidden things of nature and put them to use. It is an honest mind, for it seeks neither to deceive nor to be deceived. It is an open mind, ready to reject the truth which seems to be in favor of that which is proven to be. The scientific mind, if it be true to itself, knows no passion nor prejudice nor predilection, unless it be the passion for the truth that is not yet known, a judgment given in advance in favor of that truth when it shall be known and a preference for any form of truth whatever, and a distaste for shams. I have a friend who said that if he did not know why he knew what he thought he knew he wanted to know, and in this attitude of thought he expressed something of the outreach of the mind of science, which ever seeks to learn the what and the why of things.

In the business world facts are respected. This is so because facts are stubborn things and insist upon being respected. They have a way of bowling one over if one does not respect them. Enter a great mill and look about you. The machine which is nearest at hand is itself the illustration we seek. It is the embodiment of ascertained fact. As you stand and look at it and think of how it came to be you will find your mind running back through a long series of facts which one by one were gathered often through many years and which have ended in the mechanism which you see. If it were not made in accord with the facts out of which it grew it would cease to work and become a helpless thing. If it is not used in accordance with the facts which control its service it ceases to be useful and again becomes a helpless thing. It is made up out of past facts. It is working out present facts, and its product often points toward the development of facts which are to be.

We stand, you and I, whether in school or office or mill, in the midst of a constant evolution of facts and development of truth. The truth of yesterday is not that of to-day. The truth of to-day is but the parent of that which is to be to-morrow. Prejudice and truth are enemies, and truth has no finer task than that which it daily performs of destroying prejudice. Where prejudice is, truth is so far excluded, for no judgment given in advance of known truth is either sound or safe.

Let us not, however, go on as if we were paying mere verbal homage to a high ideal. Let us become practical in the matter. The relation men hold to truth, their respect for facts, their use of facts, largely determines their place and power in life. We make progress in the business world not necessarily by research for facts but at least by outreach for them and by respectful treatment of them when they are found. If the mill you are some day each of you to run is not run in accord with the facts that environ that mill it will not run long. Nay, you may find the more obvious facts that should control the mill and by conforming to them may succeed a little. The amount of success will depend a good deal upon how far your vision goes in seeing the facts that surround you and on the extent to which your practise goes in using those facts. The man of broad mind sees more facts than he who has a narrower vision. Mental nearsight is usually not profitable. To be farsighted is at times physically inconvenient but commercially has much in its favor. It is more essential, however, that the sight, whether it be far or near, shall know a fact when it sees it and be ready to abandon a

pseudo fact for a real one and to abide by the latter till further facts are found.

These suggestions are simple and primary, yet acceptance of them is all too rare. About all of us is a penumbra shutting out many truths we would do well to know. Amid the enlightened circle, which is perhaps not of the same size for any two of us, we walk with such light as we have. This perhaps leads us normally to repeat that profound truth from Holy Writ, "If the light that is within you (or, I may add, about you) be darkness, how great is that darkness!"

Facts have a cruel way of substituting themselves for fancies. There is nothing more remorseless, just as there is nothing more helpful, than truth. If your head comes in contact with the moving crank-shaft of an engine, the fact as to the relative hardness of the two will be both painfully and speedily determined. Yet it would not do to argue that because the crank-shaft breaks your head it was a destroying force in the world. Sometimes the head itself is more of a destroying force than the unconscious mechanism which it has created.

It is well, therefore, to be on the right side of the facts. This means that there are certain standards by which our opinions may be judged whether they are false or true. For the truth is not affected by what men think about it. Your or my unbelief in it does not make it less the truth. It is a stern though kindly standard that thus is daily set against our judgments, and if you and I fail to meet the standard it does not hurt the standard but it does hurt us. Those are fine lines which run:

It fortifies my soul to know
That though I perish truth is so;
That howsoe'er I stray or range,
Whate'er I do truth does not change.
I steadier step when I recall
That though I slip truth does not fall.

Shall men be able to rely on you in your working life? If so, it will be because they find by experience that in word and deed you meet the test of truth. Of one man we say he is fanciful; of another that he is a dreamer; of another that he is a pessimist; and of a fourth, an optimist, and by all these things we mean certain shades of criticism whereby we detect the departure from a certain mental standard of our own as to the relation a man should normally have to facts.

Prejudice then, and half truths, and narrowness of view, and obstinacy of thought, these are all weights men carry in the race of life; expensive things, bringing at times both pain and poverty into his lot who tolerates them.

I have intimated in substance that modern industry is the utilizing of certain facts or the outgrowths of them for the production of other facts; or to state it differently, that industry represents the practical application of truth to life. If one passes from the field of industry into public life there is nothing which strikes one more forcibly than the degree of absence of this relation to fact. Our scientific thought, our industrial thought, our agricultural thought, even our artistic and literary thought either pays homage to the laws of truth which govern those activities or at least panders more or less unwillingly to the recognized power of the controlling truths. This condition does not prevail to an equal degree in the discussions of public life. Nothing strikes one, leaving a business atmosphere for that of public service, more than the inaccuracy in statement and in criticism which is there found. Around the table gather the board of directors of an industrial company. As the facts concerning the company's affairs are discussed it is usual for those present to speak of the business in which they are concerned with

accuracy and for the listeners to believe that they speak the truth as they know it. I mean no personal and certainly no sharp criticism when I say that this is far from being the case when men, perhaps even the same men, meet to discuss public affairs. The things which are at times currently believed by many among us on various public subjects are not infrequently things that are not so, and criticisms are based and policies commended or condemned with astonishing frequency on the basis of things which are said to be but which do not exist. It is not throwing the standards of business discussion into excessively high relief to say that our public affairs would be vastly improved if the accuracy of statement and the courtesy when differences of opinion arise common in business circles could be transferred to public ones. This is not because the facts are not available, for most of them are such as are of public record. The condition exists in spite of these existing records, and often without consulting them. On a recent occasion it was my duty to point out that in a paragraph from an address by a well-known man of affairs on certain public subjects not a single correct statement was made; yet the facts concerning which the statements were made were all of them available on request and without expense.

It must not be understood, however, that I am now making either a sweeping or a specific charge of untruthfulness or of desire to misrepresent. I am dealing with a condition and not with persons and a condition in which persons of unquestioned probity and honor constantly act and speak concerning public affairs without the precise information on which they commonly act in private matters. This is not because they have ceased to be upright and truthful men, but because the standards respecting facts do not seem to be quite the same nor is the same care always taken to ascertain the facts. There is no question in my mind that the gentleman whose remarks I had occasion to correct would in the management of a factory be scrupulously careful to learn the facts before he spoke concerning them to his board of directors. So far, however, as my knowledge goes, though the records concerning the facts of which he inaccurately spoke are in the Department of Commerce, no effort was made to ascertain them.

Neither must it be understood that I single any one person out or any party or locality. It has been my experience that the same separation from the normal accuracies of life has occurred with men of many varying views and of different localities when they came to speak of public matters. It seems to be a general and not a particular condition.

I once noticed when having charge of a portion of the highways of an important city that many citizens spoke as if they were intimately informed respecting the somewhat technical subject of street pavements. Possibly it is because we assume that our public affairs are easily grasped by all men without special inquiry concerning them that this habitual inaccuracy appears in conversation and criticism. So far from its being easy to know and understand our multiplex public matters I think it is true that many if not most of our citizens have but vague conceptions of what the actual detailed operations of the government are. One is constantly requested in all goodwill and sincerity to do that which is impossible or even unlawful. I received but a few days since a numerously signed petition urging that the department enter upon a line of business not only unknown to the law but which would require an amendment to the constitution of the United States to make a law concerning it

possible. Possibly the fact that we have all been taught that power lies in a democracy with the people leads some to think that anything which some individuals desire is therefore both lawful and possible.

Accompanying the comments based upon absentee facts are others which deal with assumed motives having no sounder basis. It is but a few days since the unconscious act of one in no way connected with the government was made the basis of a charge that an important service had sold itself, and was described in adjectives as lurid and abusive as they were wanting in basis.

This is, however, neither a complaint of conditions nor a plea for relief, but a suggestion for helpfulness. No administrator worthy the name but welcomes candid and constructive criticism, and from many sides I have received comments and suggestions through many years that have altered methods and improved results. It is the fact of course that criticism and attack, having no basis in truth, pass by one as the idle wind which one respects not and has no result save to injure the influence of the critic who descends to such means, if it is consciously done. The problem that needs solution, however, is how to guide men who wish to speak clearly and accurately out of the all too pervading habit of doing neither when public business is concerned. It is, I believe, assumed that through the daily press we have a means of throwing light on all these things and one would be foolish to deny that much light is continually thus thrown. We must not, however, in justice to that press, forget that the nature of its service requires that what they print shall be of the day, daily, or almost of the hour, hourly; that a thing to have news value must in some degree be new or, to have what is technically called "punch," must have some element more or less of the dramatic, or must have such a character as will arrest attention. Unfortunately for the public mind, much that needs to be known has neither character. The larger part of the useful and productive work of a government department is not only nonpolitical but is continuous, developing steadily from day to day, similar in its character to the operation of a factory or a business, turning out a regular product which does not have in it always the appeal of the moment which gives it either "punch" or news value.

These things, therefore, are not and in a sense can not be grist for the mill of the daily press even though they may be more important in the way of information than that which falls more truly within the class of the said grist.

There is, therefore, something yet to be done in the way of bringing before the people who own the government the facts respecting that government in its daily evolution. It has been a pleasure to me in more than one city (among them this one) to speak of the work of the Department of Commerce to busy men of affairs. It has interested and enlightened me to see how keen an interest has been taken and how much surprise has at times been shown on learning the facts. There is every reason to believe that other departments than that of commerce contain as much if not more of interest to the average man.

I should myself be guilty of inaccuracy if there is left in your minds any impression to the effect that the press in any of its forms is deemed negligent of its duty to inform the owners of the government respecting their own affairs. This does not seem to be the case. It is rather that all the conditions are such that in a matter of grave importance to every one of us the necessary means of publicity for full knowledge by us all of our affairs is not available. We do not ignore the fact that maga-

zines of many kinds, and frequent articles in numerous other publications, throw much light upon some of the operations of various public services, but there does not seem to be available any regular and systematic source of adequate knowledge as to what is regularly going on. Books, indeed, several of them, exist having this for their purpose, and they are good to have and read. Yet it is doubtful if any of them really fulfils its mission. Such an organization as the Chamber of Commerce of the United States continuously and with effect strives to perform for the business world the function of giving knowledge concerning the government. It maintains committees which are in more or less frequent touch with different departments; it publishes a paper of much value; yet I doubt if its able and effective officers would feel that their function lay in the way of informing the whole public on all our governmental affairs or even if they would say that they had as yet reached that state of perfection of information for their own share of our public that they themselves desire.

The truth seems to be that in a republic where a knowledge of public affairs is more or less charged upon us all by the very nature of our institutions these same institutions have grown so vast and far-reaching, so intricate in their operations, that it is, to say the least, extremely difficult for any one to follow them. Indeed, one might talk to you for two hours on the work of a single bureau of the Department of Commerce without exhausting that subject, yet neither that bureau nor that department is among the largest there are. If to the burden thus imposed, happily without consciousness, upon the average man, there is added that of understanding his own state and municipal affairs, plus the duties of his own vocation, the responsibilities of the citizen of a republic would seem onerous indeed.

It would undoubtedly, however, be pushing our thought much too far to urge any such comprehensive view as the duty of any single man. For one such to follow the daily changes arising from the evolution of our national government would be itself a serious task. The important thing, and the thing which unfortunately exists far too little, is to know accurately the things which we do know. How is this to be done? Each department is a great storehouse of facts which in many ways it strives to make known and to utilize. In dealing, as we in our department do, with the promotion of our foreign trade in one of our services, the problem is ever before us how to let the business world know what we are actually doing for it. Through branch offices, by use of press and platform, by the publication of a daily paper, by official reports, monographs, and such other use of the press as brings our annual total of expenditures for printing up into the hundreds of thousands of dollars per annum, we strive to inform the people. Yet we are conscious that much more needs to be done than is in fact accomplished. It is a common thing to have men say when this or that or the other thing is shown them, "I had no idea of this." Speaking not long since to a prominent manufacturer of the work in behalf of manufactures of one of our great bureaus he said he had not even heard of the bureau. I do not mean that he was to blame. The fact is the means of informing our people on their own affairs, even in this land of printing presses and publications, either are not adequate, or if they are sufficient they do not for some reason perform the function.

Possibly some may say that official reports are not so juicy a type of literature as to afford pleasant food for the mind, and no one who has had to write such a report would argue to the contrary. Nevertheless

the facts of the government's daily work are many of them of surprising interest. The discovery of a great unknown bed of edible scallops extending hundreds of miles along the Atlantic coast, the utilization of sea mussels for food, a use common in Europe, hitherto neglected here but now springing into activity; the finding of great fishing banks close by the Oregon shore not hitherto known to exist, the maintaining of the pearl button industry by inoculating fish through a biological laboratory near the Mississippi River with a parasite which in time becomes the fresh water clam, the finding of decorative millinery in the bottom of Long Island Sound in the shape of a primitive sea animal, which becomes beautiful when both dead and dyed—these are simply part of the ordinary routine work of the Bureau of Fisheries. It would be easy to go on in this same service and tell how a certain river perch lays a mass of eggs much larger than itself and how fish exist which are good for food yet are thrown away at a time when men complain of the high cost of living. One could go on for long telling of matters of this kind. They are facts which affect daily life sometimes to the extent of altering its conditions. Here a slight change in a government specification opens a great market to American cements that were theretofore excluded; there a hint that a certain duty has been modified leads to the large exportation of coal. A few lines in print open the way to the shipment of hundreds of cases of glass abroad. The study of a ceramic chemist in the quiet of his laboratory produces a leadless glaze and destroys the evils of lead poisoning. Some work of the same man develops value out of hitherto useless clays and makes possible the production of porcelain of a kind not made here before.

It would be easy to run on. These are only faint indications of living matters of interest conducted by the public and for the public but of which the public does not get that close and intimate knowledge which it is desirable they should have.

I have not touched upon the extent to which partisanship or passion may come in to modify facts or to obscure them. I regret that it should be true that half-truths should be as common among us as they are. Let us, however, deal to-day not with matters known and controverted even though known but in part and that which is known used but partially. We have spoken rather of things of general interest that are not controversial but which in their aggregate mean the service that the people through their organized government are doing for themselves.

You will doubtless observe I have presented no remedy for the weaknesses that have been suggested. This is because I do not know of any panacea that will work any immediate or even extended cure. We are so busy in the actual work striving to make the doing useful to those for whom it is done, so actively facing the difficulties of being as helpful as we desire, that we are perhaps more conscious of the struggle than prophetic of success in it. This is not a confession of defeat, for on the contrary much accomplishment is real. It is only when we measure what all of us who own our affairs would like to know and ought to know about those same affairs beside the ability to inform them of those affairs that the task seems hard.

A mental danger besets us all. It is that of parochial thinking. It is all very well for a man when he is dead to rest his bones within the quiet shades and encircling wall of some churchyard, but he needs a larger sphere while he is alive. Up to the time when a man leaves school to begin a man's job in the world I suppose it may be said,

generally speaking, to be true that his mind has worked chiefly intensively. From that time on I suppose it to be true that the mind should work chiefly extensively. The point at which one method of thinking passes over into the other would be hard to trace. One can do extensive thinking in school and must do intensive work after assuming the work of life. None the less, generally speaking, I believe that the training of young manhood looks to the extension of thought in maturer life. You are not primarily going on to get facts out of books and out of the laboratory and out of the experience of others into your mind. You are to begin to take the facts which that mind has digested and to work them out into useful forms and into productive service. You have been perhaps the beneficiaries hitherto of the things which have been created and of the thoughts which others have worked out in the crucible of their own mental processes. You are now to become in a sense creators and to think both for yourselves and others. You have been one may say absorbers; you are to become producers. Your value as men depends on what the product shall be.

The country is not so greatly concerned, I venture to believe, with the amount that a man knows as it is with the use he makes of what he knows. It does not want the man who, while his body may live, still keeps his mind in a mental churchyard. One of the great phrases of the Old Testament says: "Thou hast taken me and Thou hast set me in a large place;" and what the world needs is men who can think in great areas. It is necessary but it is not sufficient to get the facts. One who would do a man's job in the world must through those facts serve his fellows.

Think, if you please, what the symmetry of life should be. It should not be narrow; it should not be crooked. It should be straight and square. It should be high, to keep out of the dust and mire. It should be broad that it may rest securely. It should be deep based on the eternal verities. It must not be low, for living things grow upward into the light. I would have you question all your life long whether this or that or the other form of alleged truth which is presented to you be so or not. If it is found not to be the truth I would have you reject it without regret and without fear of inconsistency, for there is some force in the statement that consistency is the virtue of weak minds. Truth is progressively revealed and one must readjust himself in thought and action to the greater knowledge of truth that we ought continually to gain. The man who at fifty thinks as he thought at thirty has mentally ceased to grow. If one's mind is open to the light whencesoe'er it may fall, if one's steps are guided by that light whithersoe'er it may lead, there is little to fear either as to treading the path safely or as to the place in the world to which it shall conduct one.

William C. Redfield

MINERAL PRODUCTION IN 1915

"The mid-year finds the mineral industries of the United States generally prosperous and enjoying a revival of active development." With this statement the director of the United States Geological Survey opens an official review of mining conditions as reported to him by the government geologists and statisticians working on this subject. "This revival is particularly true of some of the metals for which increased demands have been noted during the past six months. This country has been first thrown upon its own resources for mineral products required and, next, given the opportunity to supply the needs of foreign countries who have offered us their trade. Comparative freedom from foreign competition and, in some important cases, increase of foreign markets

have stimulated production and a general mining advance has set in." Summarizing the special reports at hand, Director Smith continues his review:

The six months' record in iron is reassuring in that hopes at the beginning of the year have been realized. Ore shipments from the Lake Superior mines have begun well, May, 1915, showing a 30 per cent. increase over May, 1914. The pig iron output is also promising in its steady increase month by month, so that a reasonable prophecy is for a greater total pig iron production for 1915 than for last year. Enlargement and extensions at the iron and steel plants furnish unmistakable evidence of returning business confidence.

The half year period just completed has witnessed great changes in the copper industry and in every particular the improvement has been notable. Prices, output and wages have shown an upward trend, and prosperity is the word in the copper districts of the United States.

The demand for spelter and lead, with the present high prices, have given a double impetus to mining in the zinc-lead districts. In the Joplin region old mines are being reopened, new shafts are being sunk, and prospecting is most active. Smelters are pushed to capacity operation. The six months' period has been altogether favorable for zinc mines and smelters, and the June advance in the price of lead makes the outlook bright for all lead mining.

In the minor metals, the first American mine to be extensively operated for molybdenite has been opened in Colorado; a tin smelter is reported as being built in New Jersey; and the Colorado tungsten mines are working full handed on full time; an antimony smelter in California has resumed operations and a new one has been erected in the same state to work California ores; and antimony ores have been shipped from Nevada and Alaska. The demand for quicksilver has increased with the result that the California, Nevada and Texas producers are expected to work at top capacity.

An unusual feature affecting coal mining has been the loss of bunker trade at the Atlantic ports, which is only partially offset by increasing exports. Reports from the west on the other hand show an increase in coal production over last year and in the east the coke output has increased considerably of late, thus showing at last the effect of the recent activity in iron and other metals.

The petroleum production for the six months just closed is believed to exceed that for the corresponding period last year. Unfortunately for the producers, this increase has not been in response to a demand expressed in higher prices. On the contrary the persistent flood of oil from the Oklahoma fields and from the new pools in Louisiana and Texas has prevented any permanent advance in price.

Reports from the survey's western offices are in the main optimistic. Colorado already shows an increase in gold output over the same period in normal years, and while the six months has shown no increase in tonnage for other ores, there has been a large increase in value and the present high prices give the promise of increased mining activity during the rest of the year. Utah is expected to reach a record output and Nevada mines are being operated at usual capacity, with new activity on the old Comstock. The lead and silver production of Idaho has only recently been stimulated, but a large increase in zinc output has already been shown. In Montana, the copper mines have about reached normal condition, the zinc production already shows a notable increase, and the gold output will be larger. New Mexico reports increases in gold, silver and zinc, while lead production has fallen off. The six months' output of copper in New Mexico was probably equal to one-half last year's output, so that there is good expectation of a better total for the year. Arizona, as a copper state, has shown the usual improvement during the six months, while the gold mines promise a record-breaking year. No large increase in Arizona's output of lead or zinc is expected in 1915 over other years. In California some gain in gold yield is reported and copper conditions are much improved over last year. Oregon shows a slight

increase in gold output; while in Alaska the outlook is good for increased output of copper as well as gold. More Alaska mines are on a producing basis this year and more dredges are in operation.

THE PACIFIC COAST MEETING OF THE AMERICAN ASSOCIATION

Times and Places of Meeting.—The opening session of the Pacific Coast meeting of the American Association, for the presentation of the addresses of welcome and the response thereto, for announcements, and for the president's address, will be held in San Francisco at 10:00 o'clock, Monday morning, August 2, in the Scottish Rite Auditorium, corner Sutter Street and Van Ness Avenue. The social reception to visiting scientists and their friends will occur on Monday evening in the reception rooms of the California Host Building, Exposition Grounds. The general sessions of the association, including three lectures on Pacific region subjects, will be held in San Francisco in the Scottish Rite Auditorium on Tuesday, Thursday and Friday evenings. There will be no session or lecture on Saturday evening. The sessions of the association and of the affiliated societies on Wednesday, August 4, will be at Stanford University. It is expected that a special train will leave San Francisco at a convenient hour Wednesday morning for Palo Alto and return to San Francisco late in the afternoon. All other sessions of the week will be held at the University of California, in Berkeley.

Registration and Information Offices.—The general headquarters of the association during convocation week, August 2 to 7, will be in the Hearst Mining Building, on the campus of the University of California, Berkeley. Secondary offices will be maintained: in San Francisco from Saturday noon, July 31, to Friday noon, August 6, in the Palace Hotel; in San Francisco on Monday forenoon, August 2, in the Scottish Rite Building, Sutter Street and Van Ness Avenue; and in Stanford University on Wednesday, August 4. Members will secure badges and programs upon registration. Mail addressed in care of the Hearst Mining Building, University of California, will be delivered as promptly as possible to those who have registered.

Hotel Headquarters.—Local representatives of several of the affiliated societies have announced selections of hotel headquarters as follows:

American Astronomical Society and the American Mathematical Society, Hotel Claremont, Berkeley.

American Physical Society, Hotel Claremont, Berkeley.

Geological Society of America, Paleontological Society of America and Seismological Society of America, Hotel Shattuck, Berkeley.

Botanical Society of America, Hotel Carlton, Berkeley.

Zoological Society of America and the Biological Society of the Pacific, Hotel Carlton, Berkeley.

Entomological Society of America, Hotel Claremont, Berkeley.

American Anthropological Association, Hotel Carlton, Berkeley.

American Genetic Society, Hotel Claremont, Berkeley.

American Psychological Association, Hotel Plaza, San Francisco, Post and Stockton Streets.

Archeological Institute of America, Hotel Bellevue, San Francisco, Geary and Taylor Streets.

Railway Tickets.—Round trip special Exposition railway tickets at greatly reduced rates are available from all points to San Francisco, Los Angeles or San Diego as the destination. The price of tickets from points east of the Rocky Mountains is the same whether the destination be San Francisco, Los Angeles or San Diego. The trip going and returning may be by the same route or by different routes, but the routes described on the tickets must be followed. Tickets from Chicago and farther east are valid going or returning via New Orleans. Tickets via Portland, Seattle, etc., involve a supplementary charge, concerning which the local railway representatives should be consulted. The baggage of those who intend to stay in Berkeley should be checked directly to Berkeley, California (by either the Southern Pacific or Santa Fe routes) instead of to San Francisco. All round trip tickets require validation for the return trip,

on the day preceding or on the day of departure. Validating agents will be found at the city ticket offices and the main railway stations in San Francisco, Los Angeles and San Diego, at the Ferry Building, San Francisco, at the Southern Pacific Ferry Pier, Oakland, and at the Western Pacific Station, Oakland. A fee of fifty cents will be charged for the validation of each ticket.

APPOINTMENTS AT THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

THE board of scientific directors of the Rockefeller Institute for Medical Research announces the following appointments and promotions:

Appointed an associate member:

Dr. James B. Murphy, hitherto an associate in the *department of pathology and bacteriology.*

The following have been made associates:

Dr. Carrol G. Bull (pathology and bacteriology).
Dr. Frederick S. Jones (pathology and bacteriology).
Dr. Clarence J. West (chemistry).
Dr. Michael Heidelberger (chemistry).
Dr. Frederick M. Allen (medicine).
Dr. Oswald T. Avery (bacteriology).
Miss Angelia M. Courtney (chemistry).
Dr. Eduard Uhlenhuth (experimental biology).

The following have been made assistants:

Dr. Harold K. Faber (pathology and bacteriology).
Mr. Chester H. Allen (chemistry).
Mr. James K. Senior (chemistry).
Mr. Glenn E. Cullen (chemistry).
Miss Mariam Vinograd (chemistry).

The following new appointments are announced:

Dr. R. Werner Marchand, assistant in department of animal pathology.
Dr. Carl Ten Broeck, associate in the department of animal pathology.
Dr. Herbert D. Taylor, assistant in pathology and bacteriology.
Dr. Oswald H. Robertson, assistant in pathology and bacteriology.
Mr. Ernest A. Wildman, fellow in chemistry.
Dr. Reginald Fitz, assistant in medicine and assistant resident physician.
Dr. Arthur L. Meyer, assistant in physiology and pharmacology.

SCIENTIFIC NOTES AND NEWS

SURGEON-GENERAL RUPERT BLUE, of the Public Health Service, was elected president of the American Medical Association at the recent San Francisco meeting.

LORD FISHER, former first sea lord of the British admiralty, has been appointed chairman of an "inventions board," which will assist the admiralty in coordinating and encouraging naval science.

DR. VIKTOR VON LANG, emeritus professor of physics at Vienna, has been elected president of the Vienna Academy of Sciences. The academy has elected as corresponding members Dr. Sven Hedin, the Swedish explorer, Dr. Max Planck, professor of mathematical physics at Berlin, and Dr. P. H. von Groth, professor of mineralogy at Munich.

AMHERST COLLEGE at its recent commencement conferred its doctorate of laws on Professor Benjamin K. Emerson, class of 1865, for forty-five years teacher of geology in Amherst College.

SHERBURNE WESLEY BURNHAM, for twenty years professor of practical astronomy in the University of Chicago and astronomer in the Yerkes Observatory, was given the honorary degree of doctor of science, at the commencement of Northwestern University.

IN conferring the Harvard doctorate of science on Dr. Frank Billings, President Lowell said: "Frank Billings, physician and citizen of Chicago; powerful in his profession and his community, who has inspired medical research, improved medical administration in his own state and promoted a higher grade of medical education throughout the land."

GENERAL WILHELM GRONER, head of the field railways of the German army, has been given honorary degrees by the University of Berlin and the Technical Institute of Stuttgart.

AMONG the fellows of the Royal Sanitary Institute recently elected are Dr. Julian Arce, director of the Department of Public Health of the Peruvian Republic, and Dr. Frank Fairchild Wesbrook, president of the University of British Columbia.

Dr. W. S. Thayer, of the Johns Hopkins Medical School, has been elected an overseer of Harvard University.

The title of professor of horticulture, emeritus, has been conferred by the University of California upon Edward J. Wickson, authority on the fruits, vegetables and flowers of California, a member of its agricultural faculty since 1880, and dean of the college of agriculture from 1909 to 1912.

Professor Charles Lee Crandall, of the college of civil engineering, Cornell University, has retired from the faculty after a service of forty-two years, and has been elected professor emeritus. Both the board of trustees and the university faculty have adopted resolutions with respect to his retirement.

Professor S. C. Lind has resigned the chair of general and physical chemistry in the University of Michigan. He has already been absent from the university for two years on leave as a member of the Denver U. S. Bureau of Mines Experiment Station, where he will continue his work on radium.

Dr. Walter Rytz has been elected curator of the collections of the Botanical Gardens at Berne.

Dr. Allen W. Freeman, of Richmond, Va., has resigned as assistant state health commissioner to become epidemiologist for the United States Public Health Service at Washington.

Governor Walsh, of Massachusetts, has appointed to the commission on terminal facilities in Boston, Professor C. M. Spofford, head of the department of civil and sanitary engineering at the Massachusetts Institute of Technology. Professor Spofford recently finished his work with the committee in Cambridge on a proper system of taxation for the city.

A position as research associate in pathology has been added to the department of pathology of the University of California for 1915–16 through the gift of Mr. James K. Moffitt, of San Francisco, a regent of the university. To this position will come Dr. H. T. Chickering, of the Rockefeller Institution for Medical Research. He will be associated with Professor F. P. Gay in investigations on the treatment of typhoid by the use of sensitized vaccine. This research associateship is in addition to a research associateship in pathology for which other donors a few weeks ago agreed to provide an annual gift of $1,200, and an eventual endowment of $25,000.

Dr. L. A. Bauer, director of the magnetic observatory of the Carnegie Institution at Washington, has presented to the Brown University Library a complete set, Volumes I. to XX., of the *Journal of Terrestrial Magnetism and Atmospheric Electricity,* founded and edited by him.

Mrs. Matilda Coxe Stevenson, for the last twenty-five years ethnologist in the Bureau of American Ethnology, died on June 24, at the age of sixty-five years.

The Vassar alumnæ of the early seventies have started a movement for the purpose of erecting a monument to the memory of Professor James Orton, who occupied the chair of natural history at the college from 1869 until his death in 1877. Professor Orton was born at Seneca Falls, New York, in 1830 and was educated at Williams College and Andover Theological Seminary. In 1866 he was appointed instructor in the natural sciences at Rochester University. In 1867 a scientific expedition to the Andes and the River Amazon was organized under the direction of the Smithsonian Institution and Professor Orton was placed in charge. On his return he accepted the chair of natural science in Vassar College, which he occupied until his death eight years later on his third expedition to equatorial America.

Frederick W. Spanutius died in Hastings-on-Hudson, on June 20, at the age of forty-seven years. He was instructor in chemistry in the Pennsylvania State College, Iowa State University and Lehigh University. Later he engaged in industrial work and owned works at Hastings called the Pan Chemical Company.

Mr. F. H. Neville, F.R.S., late lecturer on physics and chemistry in Sidney Sussex Col-

lege, Cambridge, died on June 5, in his sixty-eighth year.

PROFESSOR F. C. COOPER, for twenty years professor of chemistry in the University of St. John's, Shanghai, died on June 4, while on a furlough in England.

PROFESSOR PIETER ZEEMAN, of the University of Leiden, has died at the age of fifty years. His discovery of the effect of magnetism on the emission of spectral lines and other work in physics, have given him distinction. He received the Nobel Prize in 1902.

THE United States Civil Service Commission announces an examination on July 13 for associate chemist, for men only, to fill a vacancy in this position in the Bureau of Standards, Department of Commerce, Washington, D. C., at a salary ranging from $2,000 to $2,500 a year. It is desired to secure eligibles having a thorough scientific training and several years' experience in the investigation of problems involving the chemistry, physical chemistry and metallurgy of metals. Candidates should be able to initiate and carry on independent research in the preparation, analysis and properties of metals and alloys. Competitors will not be assembled for examination, but will be rated on education, experience and publications. Graduation, with a bachelor's degree in chemistry, from a full four-years' course at a college or university of recognized standing, and at least three years' subsequent research work in the chemistry of metals and alloys, are prerequisites for consideration for this position.

THE Bureau of Standards has completed the plans for its new chemical laboratory building, the cost not to exceed $200,000, for which appropriation was made by congress last winter. The architects, Donn and Deming, have drafted the specifications, which are about to go to press. It is expected that advertisements for proposals for the construction of this laboratory will be published during June. The laboratory will be situated on Pierce Mill Road near Connecticut Avenue, in the northwest suburbs of Washington, D. C., and will form the seventh of the group of special laboratory buildings erected for the bureau.

THE International Commission on the Teaching of Mathematics has issued, through the Bureau of Education at Washington, from which it can be obtained, a bulletin on the teaching of elementary and secondary mathematics in the leading countries of the world. This bulletin, prepared by J. C. Brown, sets forth the nature of the mathematics taught in every school year, from the first through the twelfth, in the standard type of school.

THE second annual conference of the Society for Practical Astronomy will convene August 16, 17 and 18, at the University of Chicago, Chicago, Ill. All persons interested in astronomy, and friends of the science, whether members of the society or not, are cordially invited to attend the regular sessions of the conference, and will be made welcome there. The program will consist of papers from members, illustrated lectures an astronomical subjects, and *conversazioni*. For at least two of the evenings excursions have been planned to the Dearborn Observatory of Northwestern University, in Evanston, Ill., and to the (private) Petrajtys Observatory, in South Chicago, Ill.

GOVERNOR HIRAM W. JOHNSON has declined to approve the anti-vivisection bill which was passed by the California legislature at its last session. The committee on medical instruction of the regents of the University of California, the deans of the California and Stanford medical schools, the biological and agricultural investigators, the medical profession, and many other citizens had protested against the measure as an unwarrantable interference with science. In declining to approve the bill Governor Johnson announced that its provision that any humane officer should be permitted to invade any scientific laboratory without a search warrant was an unconstitutional interference with personal liberty and the rights of privacy.

A PARAGRAPH in the latest number of *Astronomische Nachrichten*, No. 4,802, brings some encouragement as to the solidarity of science in contrast to the international animosities reported from Europe in the daily press. Pro-

fessor Albrecht begins his usual preliminary report on the international latitude service with the following words: "Although international undertakings in nearly all fields were subject to far reaching disturbances in 1914 from the circumstances of the war, the international latitude service happily suffered no interruption, and was carried out quite in the usual manner at all six stations. Furthermore, since there were no appreciable delays in sending in the observing books [to the central office at Potsdam], the preliminary derivation of the orbit of the pole could be undertaken in precisely the same maner as in previous years." It should perhaps be added that the six observing stations, on the parallel of latitude N. 39° 8′, are at Mizusawa, Japan; Tschardjui, Russia; Carloforte, Sardinia, and in the United States at Gaithersburg, Md.; Cincinnati and Ukiah, Cal.

THE total production of explosives in the United States during the year 1914, exclusive of exports, according to figures compiled by Albert H. Fay, of the United States Bureau of Mines, was 450,251,489 pounds or 225,126 short tons, as compared with 500,015,845 pounds or 250,008 short tons for 1913. The production for 1914 is segregated as follows: black powder, 206,099,700 pounds; "high" explosives other than permissible explosives, 218,453,971 pounds; and permissible explosives 25,697,818 pounds. The figures represent a decrease of 23,839,831 pounds of black powder; 23.932,573 pounds of high explosives, and 1,987,952 pounds of permissible explosives, as compared with 1913. Mr. Fay says: "As explosives are essential to mining, and the use of improved types of explosives tends to lessen the dangers attending this industry, the Bureau of Mines undertook the compilation of information showing the total amount of explosives manufactured and used in the United States, its first report dealing with the year 1912. The report for 1914 is therefore the third technical paper issued by the bureau relating to the production and distribution of explosives. In the year 1902 only 11,300 pounds of permissible explosives were used in coal mining, whereas in 1913 the quantity so used was 21,-804,285 pounds, as compared with 19,593,892 pounds in 1914. The quantity of permissible explosives used in the United States is larger than in a number of foreign countries. In 1912 it represented about 5 per cent. of the total quantity of explosives produced, and in 1914 5.7 per cent. The total amount of explosives used for the production of coal in 1914 was 220,622,487 pounds, of which about 8.9 per cent. was of the permissible class as compared with 9.5 per cent. in 1913.

THE United States Coast and Geodetic Survey, Department of Commerce, has issued as Serial No. 3, Special Publication No. 25, a quarto pamphlet of 69 pages entitled "Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1914," by D. L. Hazard. This publication contains the results of magnetic observations made on land and at sea during the calendar year 1914, together with descriptions of the stations occupied. Results are given for 385 stations in 289 localities, including an investigation of areas of marked local disturbance in Iowa and Minnesota. There is presented in tabular form a comparison of the declination results at 76 repeat stations with the results of earlier observations in the same localities. The results have been corrected to reduce them to the provisional international standard of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The stations described are located in thirty-three states and territories, including Arizona, Alabama, Alaska, Arkansas, California, Colorado, Delaware, Florida, Georgia, Idaho, Illinois, Iowa, Louisiana, Maine, Massachusetts, Minnesota, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, North Dakota, Oklahoma, Oregon, Pennsylvania, South Dakota, Tennessee, Texas, Vermont, Washington and Wisconsin. Besides the scientific value of these observations, this work is of practical utility to engineers and surveyors, and particularly to those interested in retracing old property lines. In the early days and even more recently these lines were run with the compass almost exclusively and to rerun them a knowledge of the variation of the

compass at the date of survey is essential. The volume will be supplied without charge to persons interested by application to the Division of Publications, Department of Commerce.

THE United States Coast and Geodetic Survey, of the Department of Commerce, has recently published a report, called Special Publication No. 24, which contains among other data the exact latitudes and longitudes of about six hundred stations in Alabama and Mississippi. There are also given the correct distances between each two adjacent stations and the true bearings of the lines connecting them. Some of the stations are natural or artificial objects such as mountain peaks, church spires and lighthouses but many stations required special marks or monuments to preserve them. These are frequently metal tablets set into solid rock or blocks of concrete. Complete descriptions of these marks and of the general locations of the stations with reference to other objects and to the features of the surrounding country are contained in the publication. Engineers and surveyors interested in any of the stations can easily find them from these descriptions. The publication also contains the elevations of those stations which are on high ground. The point of greatest elevation in Alabama, determined by the Coast and Geodetic Survey, and probably the highest point in that state is station Cheehahaw, on the top of the mountains of the same name, which is 2,413 feet above sea level. This mountain is about nine miles south of the town of Oxford and its top is a point of the boundary line between Talledega and Clay counties. The Coast and Geodetic Survey is publishing its geodetic data for all states as rapidly as possible. Good progress has been made along this line and much valuable information is contained in the records which are now available for free distribution. Copies of the above-mentioned publication, Special Publication No. 24, may be obtained by interested parties upon application to the Division of Publications, Department of Commerce, Washington, D. C.

THE total production of Portland cement in the United States in 1914, according to Ernest F. Burchard, of the United States Geological Survey, was 88,230,170 barrels, valued at $81,789,368; the production for 1913 was 92,097,131 barrels, valued at $92,557,617. The output for 1914 represents a decrease in quantity of 3,866,961 barrels, and a decrease in value of $10,768,249. The value assigned to the production is computed on the basis of 92.7 cents a barrel, or the average value of the Portland cement shipped in 1914. The shipments of Portland cement from the mills in the United States in 1914 amounted to 86,437,956 barrels, valued at $80,118,475, compared with 88,689,377 barrels, valued at $89,106,975, shipped in 1913. This represents a decrease in quantity of 2,251,421 barrels, and in value of $8,988,500. The average factory price per barrel in bulk for the whole country in 1914 was 92.7 cents, compared with $1.005 in 1913, a decrease of 7.8 cents a barrel. This price is about 11.8 cents higher than the average price in the Lehigh district and is near the average price in New York, Illinois, Iowa, the southeastern states and the plains states, but falls 42.5 cents below the average price received in Utah, where Portland cement brought the highest figure during the year. Among the states there were unimportant changes in rank as cement producers. Pennsylvania and Indiana held first and second places respectively, as for many years, but both of these large cement-producing states suffered an appreciable reduction of output. In 1913 the output of California exceeded that of New York and Illinois, but in 1914 this state dropped from third to fifth place. New Jersey dropped from seventh to ninth place, having been passed by both Michigan and Iowa in 1914.

IN an address before the Society of Sigma Xi, Northwestern University, February 18, 1915, Joseph E. Pogue, associate professor of geology, discussed the relation between the geology, history and ethnology of turquois. Turquois has played an important rôle among many peoples of the globe. From the dawn of civilization down to the present it has found

a variety of uses, both ornamental and religious, and always held in high esteem it has come to be invested with many interesting superstitions and woven into numerous legends. The tombs of the earliest Egyptian kings have yielded jewelry of considerable beauty wrought of gold and inlaid with turquoises from the Sinai Peninsula. The inhabitants of China, Tibet and northern India have long valued the turquois and been lavish in its use, while the Persians and neighboring races of western Asia have from time immemorial drawn upon the famous Nishapur deposits near the Caspian Sea which furnished stones of the choicest character. The Europeans during the middle ages and thereafter esteemed the Persian stones that came to them by way of Turkey, and the mineral was known in Europe even prior to the Christian era. The Aztecs of old Mexico, at the time of the Spanish conquest under Cortés, employed turquois and "chalchihuitl," an allied or similar stone of greenish hue, in many of their ceremonies, and a number of remarkable turquois mosaics carried by the conquerors to Europe attest the skill and taste of these early Indian artisans. The Spaniards, on first penetrating the region now occupied by New Mexico and Arizona, lured on by reports of fabulous riches, found the turquois there too held in high regard, and recent excavations in the ancient pueblos and cliff-dwellings of these two states have revealed a wealth of turquois ornaments that reflect considerable credit on the artistic ability of their makers. By virtue of its parallel use in parts of the Orient and America, and its curious introduction into the lore of diverse and widely separated peoples, the turquois therefore carries considerable ethnologic interest. The wide use of turquois can be attributed to four factors: Its characteristic occurrence in desert regions, due to peculiar geologic conditions there obtaining, in positions of significant contact with early trade routes and lines of important migrations; its presence at or near the surface in such occurrences, expediting its discovery by primitive man; its comparative softness, enabling it to be easily worked with the crudest tools; and its distinctive color-range from the blue of the sky to the green of water and plants, making a strong psychological appeal to uncivilized peoples, peculiarly fitting their religious ideas, and constantly suggesting symbolical application.

The quarrying of slate is an important mineral industry closely connected with the building trades. The value of slate produced in the United States in 1914, including slate sold in squares for roofing and as slabs for milling and other uses, was $5,706,787, according to A. T. Coons, of the United States Geological Survey, in the chapter on slate from the report "Mineral Resources, 1914." This was a decrease of over 7 per cent. from the value of $6,175,476 for the output of 1913. In 1914 the slate operators in general reported the demand for this material as good up to October, when the trade dropped off from 25 to 50 per cent. For the last twelve years the value of the slate output has remained practically stationary, fluctuating slightly with changes in trade and financial conditions. As compared with the output in 1905, ten years ago, which was valued at $5,496,207, the output in 1914 shows an increase in value of only $210,580, or nearly 4 per cent. The largest output ever reported was in 1908, when the value of $6,316,817 was nearly 10 per cent. greater than that of 1914. The average price per square of roofing slate in 1914 was the highest ever recorded—$4.08. This represents an advance of 39 cents in ten years. Pennsylvania, Vermont, Maine, Virginia, New York, Maryland, New Jersey and Utah, named according to rank of output, were the states producing slate in 1914. Pennsylvania produced over 63 per cent. of the total output and Vermont about 25 per cent. Nearly 73 per cent. of the value of the slate produced represented roofing slate, which is sold in "squares," each square containing a sufficient number of pieces of slate to cover 100 square feet on the roof. The output of roofing slate in 1914 was 1,019,553 squares, valued at $4,160,832, the average price being $4.08 per square. Pennsylvania's output represents about 59 per cent. and Vermont's 29 per cent. of the value of the

roofing-slate production of the United States. Virginia was the only state whose output showed an increase. Milling slate, including slate used for blackboards, school slates, electrical work, table tops, and sanitary and other structural work, decreased from $1,714,414 in 1913 to $$1,545,955 in 1914. There was an increase in the material sold for blackboards and a decrease in school slates and other mill stock.

THE United States Geological Survey has just issued, as Water-supply paper 358, a report on the water resources of the Rio Grande basin from 1888 to 1913, by Robert Follansbee and H. J. Dean. Systematic study of run-off in the Rio Grande basin was begun by the federal government near Embudo, New Mexico, soon after the passage of the act of October 2, 1888, which authorized the organization of the irrigation survey under the direction of the United States Geological Survey. A camp of instruction for hydrographers was established near Embudo, and at this camp and the gaging station near by the methods of stream measurements now in general use were systematized. In the spring of 1889 additional stations were established on the Rio Grande near Del Norte, Colo., and El Paso, Texas. From this beginning the work of measuring the waters of the Rio Grande basin has been expanded not only by the Geological Survey acting alone, but by the survey in cooperation with the American section of the International Water Commission and the state engineers of Colorado and New Mexico. At the end of September, 1913, records had been obtained at 93 gaging stations. The report contains not only all data concerning stream flow in the Rio Grande basin collected by the survey and cooperating parties but also records furnished by individuals connected with private interests. Since 1909 the state engineer of Colorado has cooperated in the maintenance of the stations in Colorado. From 1907 to 1912 the work in New Mexico was carried on under the immediate supervision of the territorial engineer. During the latter part of 1912 a cooperative agreement was made with the state engineer.

UNIVERSITY AND EDUCATIONAL NEWS

MR. JAMES J. HILL has given $125,000 to Harvard University to endow a professorship of transportation in the Graduate School of Business Administration.

A TRUST fund of $100,000, the proceeds of which are to be divided between the William Pepper Clinical Laboratory of Medicine and the Latin and Greek department, is bequeathed to the University of Pennsylvania under the will of Samuel Dickson, of Philadelphia.

THE Hahnemann Medical College of San Francisco has offered to convey all its property to the University of California, and has proposed to cease separate instruction. Instead two professorships are to be maintained in the University of California Medical School in homeopathic materia medica and in homeopathic therapeutics, the financial provision therefore to be made, for the next two years, by the homeopaths. The instruction in homeopathic materia medica and homeopathic therapeutics will be offered as elective courses. In all other respects students wishing eventually to become homeopathic practitioners will receive exactly the same instruction in the University of California Medical School as all of its other students.

DR. FRANK THILLY, professor of philosophy, has been elected dean of the College of Arts and Sciences, Cornell University, for a term of two years. He was nominated by the faculty and was elected by the trustees at the board's meeting on June 15. He succeeds Professor E. L. Nichols, whose term has expired and who will spend next year in the far east.

DR. BAILEY WILLIS, of the U. S. Geological Survey, Washington, D. C., has been appointed head professor of geology in the Leland Stanford Junior University, filling the vacancy left in this department when Dr. John C. Branner became president of the university. Professor Willis will take up his new duties with the opening of the school year in September.

DR. W. F. R. PHILLIPS, of the University of Alabama, has accepted the chair of anatomy in the Medical College of South Carolina.

Dr. Albert H. Wright, instructor in neurology and vertebrate zoology in Cornell University, has been promoted to be assistant professor of zoology. Arthur A. Allen has been appointed assistant professor of ornithology in the college of agriculture.

DISCUSSION AND CORRESPONDENCE

ELEMENTARY MECHANICS

To the Editor of Science: Four or five years ago we received several letters from our physics friends criticizing our discussion of Newton's laws of motion. One of these criticisms related to our use of the term "unbalanced force." If action and reaction are always equal and opposite they must balance each other, as some people seem to think, or in other words, it must be impossible for a body to be acted upon by an unbalanced force!

We swear by the God of Simplicity! A mule pulls forward on a cart with a force A, and the ground pulls backwards on the cart with a force B. If A and B are equal, the cart is acted on by balanced forces; but if either is greater than the other, the forces are unbalanced and the cart gains or loses velocity. The force with which the mule pulls *on the cart* and the necessarily equal and opposite force with which the cart pulls backwards *on the mule* can not balance each other because they do not act on the same body. You can not keep a thief from setting your pocketbook in motion by hanging tenaciously to a lamp post! and yet the ideas of action and reaction which are soberly held by many of our most pretentious teachers of mechanics mean exactly that when reduced to intelligible terms! Some of those who make a mess of action and reaction are like the Missouri purist who would wish to invent a fancy way of saying that Iowa is *north* of Missouri in order to avoid a verbal battle with the man from Iowa who insists that Missouri is *south* of Iowa.

Another matter has entered into the recent discussion of elementary mechanics in Science, namely, the question as to the fundamental equations of dynamics. Professor Huntington[1] is certainly wrong in claiming that the fundamental facts of Newton's second law are covered by the statement that the acceleration of a given body is proportional to the accelerating force.

[1] Science, February 5, 1915.

It is very important to distinguish clearly between the conventional content and the experimental content of Newton's second law of motion concerning the accelerating effect of an unbalanced force. There are two[2] more or less distinct points of view concerning this matter as follows:

1. We may adopt the stretch of a spring as the basis of force measurement. Then to a fair degree of accuracy *experiment shows* that the acceleration of a given body is proportional to the accelerating force; and *experiment also shows* that the acceleration which is produced by a given unbalanced force is inversely proportional to the mass of the accelerated body. In this statement the mass of the body is understood to be the result obtained by weighing a body on a balance scale.

2. We may agree to consider one force as

[2] Some physicists are inclined to a third point of view which makes nearly the entire content of Newton's second law conventional. The ratio of two forces is defined as the ratio of the accelerations produced by the respective forces when they are made to act, one at a time, on a given body (experiment only can show that the ratio so measured is the same whatever body be used); and the ratio of the masses of two bodies is defined as the inverse ratio of the accelerations produced in the respective bodies by a given force (experiment only can show that the ratio so measured is the same whatever force be used). From this point of view it is considered as a discovery that the ordinary centuries-old balance scale can be used to measure materials!

Consider any operation which always yields the same numerical result when applied to a given batch of sugar, but which yields a different numerical result when applied to a part of the batch. Such a numerical result can be used as a measure of the quantity of sugar, and if any such operation yields an invariant numerical result of extreme precision that particular operation should be taken as the quantitative definition of mass, if mass is to mean quantity of matter; but we should never forget that the adoption of any particular measure is essentially arbitrary.

twice as great as another when it will produce twice as much velocity per second when acting on a given body. It follows from this agreement that the acceleration produced by an unbalanced force is proportional to the force if the mass[3] of the accelerated body is given; and *experiment shows* to an extreme degree of precision that the acceleration produced by a given force is inversely proportional to the mass of the accelerated body. In this statement the mass of the body is understood to be the result obtained by weighing the body on a balance scale.

The great advantage of the second point of view lies in the fact that the accelerating effect of a force affords a satisfactory basis for precise force measurements; and the only advantage of the first point of view is that the stretch of a spring is easily measured and easily connected with our muscular sense.

The experimental content of the second point of view as above outlined may be derived from the simple experimental fact that *two bricks fall with the same increasing velocity and therefore with the same acceleration as one brick.* Fig. 1 shows the pull of gravity F

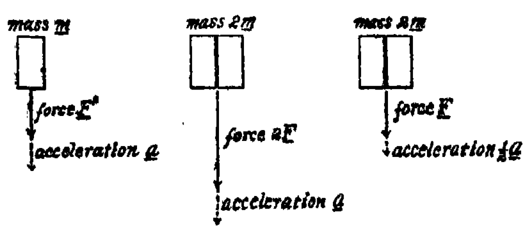


FIG. 1. FIG. 2. FIG. 3.

on one brick of mass m, and the acceleration produced is a. Fig. 2 shows the pull of gravity $2F$ on two bricks of mass $2m$, and the acceleration produced is a. Now suppose we reduce the force on the two bricks to half the value it has in Fig. 2, then according to our agreement[4] the acceleration produced will be halved, as indicated in Fig. 3. Then by comparing Figs. 1 and 3 we see that the acceleration produced by a given force is halved if the mass of the accelerated body is doubled.

The accelerating effect of an unbalanced force is the starting point of the science of dynamics, and the importance of the above discussion can not be overestimated. It must be remembered, however, that there is an extremely wide variety of effects which forces produce. Thus one may exert a steady pull on a body *to overcome friction and keep the body in motion;* one may exert a steady pull on a spring *to keep the spring stretched;* a ball bat exerts a great force on the ball *in setting the ball in motion;* steam *is condensed* into water when it is compressed; ice *is partly melted* when it is compressed; and so on.

Another matter which is always dragged into every discussion of elementary dynamics is the distinction between mass and weight, and although men like Professor Hoskins[5] are never confused thereby, others are confused hopelessly.

By a certain weight of material we nearly always mean in everyday life an amount of material as measured by a balance scale. Thus we speak of ten pounds of sugar or five tons of coal as weights of these substances. This popular meaning of the word weight is the precise and accepted meaning of the word mass as used by scientific men. Coal dealers and scientific men use the same units of mass, namely, the pound or the kilogram, whereas a diminishing group of engineers would have us measure coal in terms of what John Perry has, in semi-ridicule, called the "slug," the

[3] Strictly, if the accelerated *body* is given, because experiment only can show that a given force will produce the same acceleration in different bodies of the same mass.

[4] Our agreement to consider F as half as great when a is half as great does not, in all strictness, apply here. Of course we can, by definition, consider the pull of the earth on one brick to be half as great as the pull of the earth on two bricks, but experiment only can show that the pull of the earth on one brick would, if applied to two bricks, produce half as much acceleration as the pull of the earth on two bricks! This statement and the statements given in the previous footnotes are intended to convey some idea as to the immense amount of experimental fact there is in Newton's second law of motion, however we may attempt to simplify it by agreements as to formal definitions.

[5] SCIENCE, May 7, 1915, pages 684–685.

amount of material which would be accelerated at the rate of one foot per second per second by the gravity pull of the earth on a one-pound body at 45° north latitude and at the level of the sea.

The word weight according to scientific usage means the force with which the earth pulls on a body, and it can be expressed most intelligibly in dynes or poundals.

Many teachers of engineering conform to the popular usage in that they employ the word weight to designate the absolutely definite and invariant result which is obtained by weighing a body on a balance scale, and to get what they call the "mass" of the body they divide this so-called weight by the acceleration of gravity which is a variable! They do not remember, as Professor Hoskins does, that they should use the value of the acceleration of gravity at a certain place which has been agreed upon, and this is equivalent to saying that they do not understand what they are doing when they divide by "*g*." We wish indeed that the thing were as simple as Professor Hoskins thinks[6] it is, namely, a mere matter of dividing by 32.1740; and of course it is just that simple —to the man who understands it.

W. S. Franklin,
Barry MacNutt

PRE-WISCONSIN GLACIAL DRIFT IN THE BOSTON BASIN

To the Editor of Science: During the past few weeks exposures have been made in connection with extensive excavation work in the city of Boston where one, and possibly two, pre-Wisconsin drift sheets have been uncovered.

The evidence consists of a zone of extremely weathered material beneath the Wisconsin drift, an erosion unconformity, different types of deposits, a slight trace of an interglacial soil, some interglacial subsoils, and an apparent difference in direction of the source of included debris. It was possible to determine with some accuracy the zone of post-Wisconsin oxidation, and the final shaping of the ridge in which this evidence was found appears to be due to the re-advance of an ice sheet which slightly contorted the uppermost waterlain materials. The axis of this ridge is accordant with the direction of the striæ of the last glacial advance in the region.

A paper is now in preparation covering in more detail this important clue to older Pleistocene deposits in eastern Massachusetts.

R. Preston Wentworth
Harvard University

A SERIOUS NEW WHEAT RUST IN THIS COUNTRY

On May 21 of this year, a party representing the office of cereal investigations of the U. S. Bureau of Plant Industry discovered the yellow leaf rust (*Puccinia glumarum* Eriks. and Henn.) of wheat on several varieties of wheat in a field in the vicinity of the Indian school at Sacaton, Ariz. The presence of the rust was first called to the attention of the party by Dr. F. Kølpin Ravn, of Copenhagen, Denmark, temporarily employed by the U. S. Department of Agriculture in consultation with officials of the department on cereal diseases. At about the same time, A. G. Johnson found the rust also on *Hordeum murinum* in southern California. The rust was not afterwards found on wheat anywhere in California, but later, during June, was found in considerable abundance at various places in Oregon and Washington, and to some extent in Idaho, and a very few specimens at Bozeman, Mont., and Logan, Utah. Up to July 1 it has not been seen anywhere east of the Rocky Mountains. In Oregon and Washington the rust was also found on barley, and at Pullman, Wash., it was found by the writer on a species of wild grass as yet unidentified.

In various minor ways Dr. Ravn has been of great help to the cereal pathologists, but the discovery of the presence of this rust is a particularly interesting example of the benefit resulting from a cooperation of foreign botanists occasionally in the investigation of problems in this country with which such men are already acquainted in their own country. This rust being common in Europe and usually the

[6] See footnote on page 685, Science, May 7, 1915.

most serious one, it was readily detected by Dr. Ravn, and after calling it to the attention of others it was not at all difficult to recognize it again.

It has always been a matter of surprise to the writer that this rust has not occurred in North America before, the rust being so common in Europe and samples of wheat constantly passing back and forth. Nevertheless, its existence this season in such abundance in portions of Oregon and Washington makes it evident that either the rust has increased with remarkable rapidity or has already existed in the country for several years. The latter, if true, would be in face of the fact that it is easily distinguished from other rusts and that pathologists have been actively studying the rusts of the country. Further details of the occurrence of the rust will be reported later.

M. A. CARLETON

July 3, 1915

SCIENTIFIC BOOKS

A Study of the Orbits of Eclipsing Binaries. By HARLOW SHAPLEY. Contributions from the Princeton University Observatory, No. 3, 1915. 4to. Pp. vii + 176.

In astronomical literature one of the most frequent subjects refers to the "orbit" of a heavenly body. In fact, for a long time a standard topic for a doctor's thesis was the determination of the definitive orbit of a comet. Here the task of the candidate was to derive from observations, made in all parts of the world, the best possible numerical values for the six elements or constants which define the path of the comet as a conic section in space with the sun at the focus. Other classes of orbits are those of visual double stars, spectroscopic binaries, and finally, as in the work under review, we have what may be called photometric orbits, since the results are based upon observations of the light variations of stars.

Even to those familiar with the subject, the amount of mathematical analysis that has been based upon the changes of some of the variable stars is a source of wonder. As an illustration may be mentioned the famous star *Algol*, which has been the subject of half a dozen extended monographs, scores of papers and literally tens of thousands of observations. The special importance of the stars whose variations are due to the eclipses of large close companions is due to the fact that these systems give us the only satisfactory clue to the actual diameters of stellar bodies. The theory of such cases has been well understood for a long time, but recently Professor H. N. Russell, of Princeton University, has developed a new method for determining the elements of eclipsing binaries. He recognizes the fact that measures of the light of stars are seldom if ever accurate to one per cent., so that approximate and graphical methods are sufficient for any case that can arise. In essence his method consists of solving not directly for the elements of a double system, but for the best light-curve that will represent the observations, and then the characteristics of the system are easily computed from the curve. A series of papers on this general subject have appeared by Russell and Shapley, and the present contribution summarizes much of the previous work. Though not so stated, it is understood that this is a thesis for the doctor's degree, with subsequent additions to bring the work into complete form.

Whereas formerly an exhaustive study of one star was thought to be quite a piece of work, Dr. Shapley with the new methods has undertaken and carried through a pretty thorough discussion of 90 eclipsing stars, or all for which any sufficient data exist at the present time. We learn that the discussion of a single object required not less than a day, nor more than two weeks. Even though nearly all of the observational material was already available, it was a considerable task of mere routine to get it together, and one of the advantages of this memoir is that it will serve as an index to the best sources of information concerning any particular star.

There is a vast difference in the quality and completeness of the data for different systems, and many of the numerical results are avowedly only rough, or perhaps even guesses. In particular, the proportion of light which comes from the fainter component, as indicated by the secondary eclipse, has to be assumed in

the majority of cases. As practically everything else depends upon this guess, the further discussion is for many stars only an indication of what may be true. This limitation is well enough understood by the author, but there is danger that a casual reader, on seeing the array of tabular results, will infer that all of the numbers rest upon a secure observational basis.

The title of the work is something of a misnomer, as in the table of so-called orbits we find for each system, in addition to the characteristics of the light variation and relative paths of the bodies, the radius of each in terms of the distance between them; the proportion of light given by each component; their densities; constants giving the approximate shapes of the ellipsoids produced by tidal action; and finally the hypothetical dimensions and parallax of each system, based upon certain assumptions. There is omitted, however, the quantity which may be rigorously derived, namely the mean density of the system, which does not depend in any way upon an assumption as to the total mass, or how it is divided between the two bodies. Russell and Shapley were the first to take into account generally the probable darkening of stellar disks toward the limb, such as exists in the case of the sun, and throughout this work the results are given as based upon the alternative or limiting cases of apparently uniform disks, and of bodies completely dark at the apparent edge. The convenience of the description leads to such anomalous terms as a "uniform orbit" and a "darkened density."

It has been fairly well known that the fainter component of an eclipsing system is likely to be the larger, but Shapley now points out that this is due to the manner of observational selection. The most usual cases actually existing consist of systems with small faint companions, the apparent preponderance of the other type being due to the fact that large companions produce greater variation in light, and hence are more readily discovered.

Thanks to the work of the Harvard Observatory, the spectra of most of the eclipsing stars have now been classified, and one of the most interesting results comes in the relation between spectral class and density. Shapley finds that the white stars of the Orion and Sirian type range from slightly less than the solar density to 1/100 of this amount; but among the yellow stars, having the same spectrum and presumably the same surface conditions as the sun, there are densities ranging from three times larger than the sun's to only 1/100,000 on the solar standard. This extreme range in eight stars needs to be supplemented by more data, but so far as it goes the evidence supports Russell's contention that there are two classes of yellow and red stars, the so-called giants and dwarfs, the latter being much more condensed than the former.

The use of hypothetical parallaxes may not appeal to some students of exact science, but, after all, the assumption that a double system has twice the sun's mass, combined with a reasonable estimate of the surface intensity of a star with known spectrum, gives valuable information. Most of these eclipsing systems are at such great distances that direct measures of parallax are absolutely hopeless; and since the computed distance varies only as the cube root of the assumed mass, good estimates of probable average distance are obtained. The general inference from the eclipsing binaries confirms the conventional view that the universe of stars is more extended in the direction of the Milky Way than at right angles to that plane.

The general discussion of results covers twenty quarto pages, but a summary on a single page would have been welcome. In fact, there is some difficulty in the reader's getting all out of the work that is actually there; for instance, there is no discussion showing what is a normal or average eclipsing binary. Using Shapley's data, the reviewer finds it probable that the preponderant type of eclipsing system consists of two bodies with a distance between centers of about five times their average radius, a period of four days, and a mean density 1/20 that of the sun.

In view of the present rate of discovery of eclipsing stars, and the prospect of many more additions from the list of spectroscopic binaries, the new methods of treating the observational data are especially welcome, and all

told the work at Princeton as illustrated by the contribution under review, marks an important advance in this department of astronomy.

JOEL STEBBINS

An Index to the Museum Boltenianum. By WILLIAM HEALEY DALL. Smithsonian Publication No. 2360. 1915. 8vo. Pp. 64.

Rarely has the credit of a great life's work approached more perilously near oblivion and still be enrescued and enshrined in proper setting, than did that of the conchologist J. F. Bolten, of Hamburg. His life was practically his collection, systematically arranged, large, beautiful. In the arrangement of his collection he followed his own system, far in advance of that proposed previously by Linnæus. An outline manuscript was prepared of this system, and some illustrations were prepared by an artist-friend, Schulze by name, but death deprived the work of the artist's aid, and Bolten's infirmities prevented the prosecution of the undertaking. The outline of the system published by the family in 1798 after Bolten's death would only have been of value to the world as showing the size of the Bolten collection had not a second friend, Roeding by name, seen to it that specific names were accompanied by references to Gmelin's "Systema" and to the figures in the Conchylien Cabinet and elsewhere. In 1819 another edition serving as a sale catalogue was published; but both editions have long ago become very scarce and well-nigh forgotten. Again, a third friend, Dr. Dall, in a distant land, united a private donation with a small grant from the American Association for the Advancement of Science and had the same turned over to Sherborn and Sykes of the British Museum (Nat. History) who brought out a phototypic copy of the edition of 1798 (1906). Now, we have before us finally an elaborate and convenient index to this edition prepared by the same thoughtful friend and published as noted above by the Smithsonian Institution. It is naturally to be regretted that funds did not permit of the publication of the index with the volume, but nevertheless there is real satisfaction in feeling that the work is now in available form and the labors of Bolten shall not be forgotten.

G. D. HARRIS

PALEONTOLOGICAL LABORATORY,
CORNELL UNIVERSITY

THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (NUMBER 6)

THE sixth number of Volume 1 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *Confirmatory Experiments on the Value of the Solar Constant of Radiation:* C. G. ABBOT, F. E. FOWLE and L. B. ALDRICH, Smithsonian Institution, Washington, D. C.

Observations at Mt. Wilson from sunrise until ten o'clock and records obtained by a recording pyrheliometer attached to sounding balloons rising to the altitude of 24 km. confirm the value 1.93 calories per square centimeter per minute previously obtained for the radiant energy received by the earth from the sun.

2. *Variation of Flower Size in Nicotiana:* T. H. GOODSPEED and R. E. CLAUSEN, Department of Botany, University of California.

During five years of study of the inheritance of flower-size in *Nicotiana,* it has been found that the flower-size is not so constant as it has been assumed to be, but is affected by a number of conditions, some of which may not effect the length and the spread of the flower in the same manner.

3. *Retention in the Circulation of Dextrose in Normal and Depancreatized Animals, and the Effect of an Intravenous Injection of an Emulsion of Pancreas upon this Retention:* I. S. KLEINER and S. J. MELTZER, Department of Physiology and Pharmacology, Rockefeller Institute for Medical Research.

In normal animals the circulation possesses the ability to get rid readily of a surplus of dextrose injected intravenously. This ability is impaired in the absence of the pancreas, but can be temporarily restored by intravenous injections of pancreas emulsion. Such injections, moreover, are capable of reducing the hyperglycæmia due only to depancreatization.

4. *Parthenocarpy and Parthenogenesis in Nicotiana:* T. H. Goodspeed, Department of Botany, University of California.

Mrs. R. H. Thomas found frequent cases of parthenogenesis in *Nicotiana*; but other experimenters have been unable to verify these results. The present investigation, conducted upon the particular strains of tobacco of which seeds were furnished by Mrs. Thomas, shows that in those strains parthenocarpy is a frequent occurrence and that parthenogenesis is also peculiar to this variety.

5. *Exogamy and the Classificatory System of Relationship:* R. H. Lowie, American Museum of Natural History, New York City.

The exogamous factor must have been a real cause in moulding the kinship terminology of at least some so-called classificatory system. This conclusion is reached by a study of the character of two Siouan tribes, the Crow and Hidatsa.

6. *Solution of an Infinite System of Differential Equations of the Analytic Type:* F. R. Moulton, Department of Astronomy, University of Chicago.

If the number of mutually gravitating bodies in the universe is infinite, and if beyond a finite number of them their initial distances from one another increase with sufficient rapidity as the number of bodies increases, there is a rigorous, though limited, solution of the problem of infinitely many bodies.

7. *Sex Ratio in Pigeons, together with Observations on the Laying, Incubation and Hatching of the Eggs:* L. J. Cole and N. F. Kirkpatrick, College of Agriculture, University of Wisconsin.

A seven-years' study of inheritance in pigeons leads to the conclusion that the normal ratio of the sexes of pigeons hatched is 105 males to 100 females; that the number of unisexual broods exceeds the number of bisexual broods; that there is no tendency for first-laid eggs to hatch males and second-laid eggs to hatch females; that there is a correlation between the time of hatching the second egg and that of laying the first; that the birds continue to set beyond the normal period of incubation if the eggs do not hatch.

8. *Vividiffusion Experiments on the Ammonia of the Circulating Blood:* A. Rohde, Department of Pharmacology, Johns Hopkins Medical School.

The generation of ammonia in shed blood occurs in the non-diffusible constituents of the blood.

9. *126 Parabolic Orbits of Meteor Streams:* C. P. Olivier, Leander McCormick Observatory, University of Virginia.

Although the most important feature of this investigation is the calculation of 126 parabolic orbits, the most interesting result is the final proof of the connection of the Halley's and η Aquarid meteors. It is further concluded that radiants are not stationary.

10. *The Basal Silurian Formations of Eastern North America:* C. Schuchert, Peabody Museum, Yale University.

Medina, Cataract and Brassfield are to be retained as names for independent marine faunas and formations.

11. *A Method of Obtaining Complete Germination of Seeds in Œnothera and of Recording the Residue of Sterile Seed-like Structures:* B. M. Davis, Department of Botany, University of Pennsylvania.

By sowing seeds upon pads of filter papers placed in Petri dishes and thoroughly soaked and by keeping the culture under unvariable temperatures rapid germination was obtained.

12. *The Osmotic Pressure of the Ions and of the Undissociated Molecules of Salts in Aqueous Solution:* Stuart J. Bates. Throop College of Technology, Pasadena.

The author shows how the partial osmotic pressures of the ions and of the unionized molecules can be calculated by thermodynamic principles from the freezing-points and conductance-ratios at a series of concentrations. The results show that in general the osmotic pressure of univalent ions is considerably smaller and that that of the undissociated molecules is very much larger than would be required by the osmotic-pressure law of perfect solutions.

13. *The Extension of the Spectrum beyond the Schumann Region:* Theodore Lyman, Jeffer-

son Physical Laboratory, Harvard University.

The author has been able to reach the wavelength λ 600, and finds 7 or 8 lines in the helium spectra between λ 900 and λ 600, some of the lines being fairly strong.

14. *Unsymmetrical Lines in Tube-Arc and Spark Spectra as an Evidence of a Displacing Action in these Sources:* A. S. KING, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The observed effects seem to be harmonized by considering as a necessary condition the presence of electrified particles moving at high velocities, these being produced in the arc and spark by the strong potential-gradients and in the tube-arc by the large consumption of energy.

15. *On the Factorization of Various Types of Expressions:* HENRY BLUMBERG, Department of Mathematics, University of Nebraska.

The methods of E. H. Moore's "General Analysis" are applied to giving a uniform central theory for factorization of different series of expressions.

16. *The Direction of Rotation of Sun-spot Vortices:* GEORGE E. HALE, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Of the two spots in the typical spot-pair the preceding spot in the low-latitude zone is counter-clockwise north, and clockwise south, of the equator; corresponding to the direction of the rotation of terrestrial tornados. In high latitudes the signs are reversed, giving a result which is likely to prove significant in future studies of the sun.

17. *Some Vortex Experiments Bearing on the Nature of Sun-Spots and Flocculi:* G. E. HALE and G. P. LUCKEY, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Some of the phenomena of single and multiple sun-spots can be imitated by simple laboratory experiments in which vortices are formed in a water tank with an atmosphere of smoke above the water. Such experiments may assist in accounting for certain characteristic structures and motions of the solar atmosphere.

EDWIN BIDWELL WILSON

NOTES ON METEOROLOGY AND CLIMATOLOGY

THE WEATHER ELEMENT IN AMERICAN CLIMATES

CLIMATE may be defined as average weather. Thus Professor R. DeC. Ward is fully justified in opening a discussion of the climates of the United States with a chapter on the Weather Element in American Climates.[1] Winter weather is characteristically changeable. The rapid motions of strong cyclones and anticyclones, with the sun low in the heavens, places the weather primarily under cyclonic control. On the other hand, in summer, when cyclone activity is weak and the sun is high in the sky, the weather under the regular solar control is much the same from day to day. In spring and autumn, the interplay of these two controls is strikingly apparent. A cyclone approaches, giving rise to easterly winds, cloudy weather and rain, with a falling barometer. The solar control vanishes. However, as the storm passes and westerly winds follow, the clouds break away and the diurnal control again dominates.

Weather types depend largely on the origin of the winds which flow towards passing cyclones. Thus, on the eastern coast easterly winds are usually damp and westerly ones dry. In winter, the easterly and southerly winds are warmer than those from the west and north, but in summer the west winds are generally warmer than the east. The same holds true for the central valleys and great plains except that the east winds of summer are often warm. Furthermore, the winter cyclones fail to bring much precipitation to the great plains because of the prevailing cold. On the Pacific coast, west winds are damp and equable; while the land winds from the north and east are dry, and bring the extremes of temperature.

The frequency with which different weather types occur, depends primarily on the paths and frequency of cyclones. In winter, cyclone paths cover practically the whole United

[1] *Annals of the Association of American Geographers*, Vol. IV., 1915, pp. 3–54.

States and cyclones are numerous in the south. With the approach of summer, the cyclone paths move northward with the advance of the sun. Thus, in summer, cyclones generally move along the northern border of the United States. On account of this migration of cyclone paths it is evident that the northerly and easterly types of weather are more frequent in winter than in summer.

Through the masterly treatment of his subject, Professor Ward makes an effective attack on the tendency to describe climates without a thorough consideration of the weather element.

TYPES OF STORMS OF THE UNITED STATES AND THEIR AVERAGE MOVEMENTS[2]

THIS monograph by E. H. Bowie and R. H. Weightman, of the Weather Bureau, considers the cyclones of the United States from the forecaster's point of view. The 2,597 cyclones shown on the morning and evening weather maps for the years 1892–1912 inclusive are here ably classified and discussed. The data in the voluminous tables are also presented on charts showing for each five degrees square the number, direction and speed of movement of storms classified by regions of origin and by months. The West India cyclones are strikingly portrayed on monthly maps showing their average movements for each 2½ degrees square.

The discussion, although only ten pages long, is well supported by the 21 years of cyclones and the writers' wealth of experience in forecasting. The immediate control of the types of cyclones and their movements is apparently exerted by the subpermanent "high" in the middle latitudes of the North Atlantic and by the center of action known as the "Aleutian low." When the former is well developed, the lows and highs usually move along high latitudes; and stable temperatures above the seasonal average are experienced over the eastern half of the United States. When the Aleutian low is well-developed and south of its normal position, cyclones enter and cross the United States in low latitudes and are accompanied by stormy weather and great alternations in temperatures. Apparently, the cyclones entering the country from the west and north are offshoots from this subpermanent low.

The authors have indicated how the movements of cyclones are apparently closely connected with the temperature, wind, and rain conditions in the vicinity of the cyclonic center. Also the general pressure distribution and pressure changes influence cyclones. These connections are of direct value not only to the forecaster but also to the meteorologist studying the dynamics of cyclones.

METHODS OF CLIMATIC PRESENTATION

Equipluves or Isomers.—In the *Scottish Geographical Magazine*, July, October and November, 1914, and February, 1915,[3] Mr. B. C. Wallis has presented the monthly rainfall of Africa, Australia and the eastern United States by means of equipluves (lines which show the rainfall in proportion of the annual). The maps of Africa and Australia afford excellent examples of the value of this method. In spite of the almost total lack of rainfall in parts, the maps show the monthly importance of the rain there as elsewhere. Thus the swing of the tropical and subtropical rain belts with the sun is shown more clearly than on maps of actual rainfall.

In the eastern United States the rainfall intensity as well as the actual amount of precipitation depends on three factors: (1) the "swing of the sun," which has its most marked effect farthest from the sea; and is characterized by summer rains and winter dryness; (2) the proximity of the ocean, which, by causing heavy rainfall, makes to some extent the effect of insolation; and (3) local temperature conditions which have their most marked effect in causing variations in the months of maximum and minimum intensity of rainfall.

Dr. H. R. Mill and Mr. Carle Salter, of the British Rainfall Organization, have applied much the same method to the study of the

[2] *Mo. Weather Rev. Supplement*, No. 1, 37 pp.; 114 charts, November, 1914.

[3] See also *Mo. Weather Rev.*, January, 1915, pp. 11–24.

rainfall of Great Britain.[4] In winter (December, January and February) the highest rainfall percentages are found in the southwest portions of the British Isles; for there, the comparatively warm, moist ocean winds are cooled on reaching land. In spring, with the rise of land temperature relative to that of the ocean, there is generally deficient rainfall, the highest percentages occurring in the east. For the summer quarter, the eastern percentages rise to more than 30 locally while those in the west remain below 25. In autumn, the rainfall exceeds 30 per cent. of the annual total on the coasts of England and Scotland while the maximum is less intense in Ireland. Such maps, free from the confusing details of the actual rainfall distribution, are well fitted for exhibiting the seasonal rainfall variations.

Thermal Anomalies.—Of two methods of indicating thermal anomalies, the first, and that most generally used, is to construct isonomalous lines which show the difference between the temperature of a place and the mean for its latitude—no account being taken of the relative amounts of land and water. In the *Scottish Geographical Magazine*, July, 1914 (pp. 356–363), Mr. B. C. Wallis has presented apparently the first monthly maps of thermal anomalies of the world. The negative anomalies of the continents in winter become positive in summer, while the positive anomalies of the oceans in winter change to negative. As the northern hemisphere summer approaches, there is a weakening of anomalies throughout the world, a feature due to the unequal distribution of land in the two hemispheres.

The other method of computing thermal anomalies is based on the difference between the temperature of a place and the temperature its latitude would have if the hemisphere were wholly land (if the place is on land) or wholly water (if the place is marine in location). These anomalies Mr. J. Liznar calls "true thermal anomalies."[5] Thus such figures give a true measure of the degree of land or ocean influence, but do not necessarily show the difference in temperature between one place and another in the same latitude. The accompanying table indicates the sea level temperature of the different latitudes of land and water hemispheres:

Lat.	0	10	20	30	40
Land	33.7° C.	32.6	29.3	23.8	15.8
Water	23.9	23.2	21.0	17.3	12.3
Difference	9.8	9.4	8.3	6.5	3.5
Lat.	**50**	**60**	**70**	**80**	**90**
Land	5.4	−7.5	−19.7	−36.1	−28.3
Water	5.6	−2.1	−9.0	−12.2	−13.5
Difference	−0.2	−5.4	−10.7	−13.9	−14.8

Land in any latitude is generally colder than if the earth were entirely land. The exceptions are Europe, North Asia south to 60° and western North America. At 70° N., Greenland has a great positive anomaly of 17.3° C. and the northwest coast of Norway one of 22.1° C. The greatest negative anomalies are on land near the equator. The oceans are mostly too warm for the latitude but the anomalies are smaller than those on land. Areas of negative anomalies are the south Atlantic and south Indian oceans, and the west coasts of North and South America. The anomalies show clearly the transportation of warmth by air and water.

Climatic Profiles.—So many elements are now shown on separate climatic maps that it is difficult to get general impressions of climates. Dr. K. Mahler[6] has proposed the use of climatic profiles as a remedy. To illustrate he has chosen three profiles in India. Curves of mean temperature, air pressure, precipitation, cloudiness, relative humidity and vapor pressure are placed one above the other over a profile of land relief. In such a single picture the fluctuations of the climatic means are easy to determine and compare. Dr. Mahler suggests (as did Henry Gannett in 1902, *Monthly Weather Review*, April, 1902) the establishment of lines of observatories

[4] "Isomeric Rainfall Maps of the British Isles," *Quart. Jour. Roy. Meteorological Soc.*, January, 1915, pp. 1–44.

[5] *Meteorological Zeitschr.*, February, 1915, pp. 69–73.

[6] *Verein f. Erdkunde*, Dresden, Mitteilungen bd. 2, pp. 745–48; 3 pl., 1913.

along characteristic profiles. In this way, at slight expense we might be able to gain a more complete understanding of the climatology of a region.

VON HANN'S LEHRBUCH

METEREOLOGISTS in this country welcome the completion of Dr. Julius von Hann's "Lehrbuch der Meteorologie," third edition.[7] This monumental bibliographical text-book takes its place at the head of works on meteorology. The full title is: "Lehrbuch der Meteorologie" von Dr. Julius von Hann, Professor an der Universität Wien. Dritte unter Mitwirkung von Professor Dr. Suring (Potsdam) umgearbeitete Auflage. Leipzig, 1915, Chr. Herm. Tauchnitz. Pp. xiv + 847, 28 pl., 4 tables, 108 figs. in text. Price 36 marks.

CHARLES F. BROOKS

OFFICE OF FARM MANAGEMENT,
WASHINGTON, D. C.

SPECIAL ARTICLES

A CULTURE DIFFERENCE BETWEEN THE PIMA AND PAPAGO INDIANS

IN an expedition for the anthropological department of the American Museum of Natural History to the Southwest in the winter of 1901–1911, a number of new facts were obtained during a comprehensive study of the textile arts in two dozen villages of the linguistically related Papago and Pima tribes, which soon will be fully treated in a forthcoming publication of the American Museum.

All who had previously gone among these tribes reported that the coiled basketry bearing the conventional black designs is the same in the two tribes. The existence of a marked difference had eluded former students, but was disclosed by an intensive study of their textile arts. The identity of Pima and Papago basketry was a natural inference, as there is constant trading between them, and in many of the Papago huts are to be found, along with their own coiled baskets, those of the Pima, obtained by exchange for other articles made exclusively by the Papago.

The discovery of a distinct Papago coiled ware is a vital point, since it gives an individuality, a distinct place, to Papago coiled basketry, setting it apart from coiled ware of other tribes. The distinguishing features when compared with Pima baskets, appear in shape, in substantialness of build, and in design: for the base of these old bowls and trays is flat and broad, in contrast to the narrow base of the Pima; the walls are thick, firm, and in strong spherical curves, in opposition to the thin, pliable walls in more subtle, delicate curves of the Pima; the designs reversed and on a horizontal and vertical plan, contrary to the active, spiral arrangement of the Pima. I learn from Dr. Fewkes, who has made an extensive archeological study of the region, that this cultural differentiation may be regarded as an important discovery in connection with the problem of correlating archeological data from the prehistoric people of the same area.

The expedition was fortunate in securing some very interesting material, among which was an old Pima sleeping mat, which long ago ceased to be made for lack of material, since the white man has cut off the water supply from the headwaters of the few rivers along which the rush, *Phragmitis communis*, used to grow. There was also obtained a Papago ceremonial food bowl, used only when the medicineman goes upon religious pilgrimages for the sacred salt found below the Mexican boundary. On these journeys his food consists of pinole, eaten from this water-tight basket-bowl, out of which he also drinks. Another even greater acquisition was six Papago medicine baskets enclosing the magic accessories for curing the sick and also for controlling the weather: two of these were rain baskets, one contained medicine for healing rheumatism and the diseases of old age, another a remedy for fever, still another for keeping off the Apache, whom they very much feared, and the sixth a white powder given to infants and their parents to secure protection during life from evil spirits.

MARY LOIS KISSELL

NEW YORK

[7] Review by Professor R. deC. Ward, SCIENCE, November 27, 1904, pp. 785–86.

NEW ORLEANS MEETING—AMERICAN CHEMICAL SOCIETY—II

DIVISION OF FERTILIZER CHEMISTRY

J. E. Breckenridge, *chairman*
F. B. Carpenter, *secretary*

J. E. BRECKENRIDGE: *The Availability of Organic Nitrogen.*

H. C. MOORE: *Results of Some Coöperative Work on Determination of Sulfur in Pyrites. Some Observations on Details of Manipulation, Sources of Error and on Barium Sulfate as Precipitated Under Different Conditions.*

F. R. PEMBER and B. L. HARTWELL: *The Activity and Availability of Insoluble Nitrogen in Fertilizers Determined by Chemical and Vegetation Tests.*

F. W. ZERBAN: *Fertilizers for Field Crops in the South, west of Alabama.* (Lantern.)

B. B. ROSS: *The Determination of Potash in Fertilizers.*

G. S. FRAPS: *Effect of Lime and Limestone upon Acid Phosphate.*

BIOLOGICAL CHEMISTRY DIVISION

Carl L. Alsberg, *chairman*
I. K. Phelps, *secretary*

C. L. ALSBERG: *The Control of Cotton-seed Products.*

There is great economic waste due to deterioration of cotton seed. This deterioration is due to the storage of much of the seed in presence of moisture. This excess of moisture leads first to loss of substance by respiration, then by fermentation and heating. Both respiration and spoilage affect particularly the oil, as they are accompanied by saponification and the formation of unsaturated fatty acids of low molecular weight. Too little attention has also been paid in the traffic in seed to the relative proportion of oil, hull, protein and moisture in the seed. In order that this waste be avoided seed should be dealt in on the basis of content of moisture, oil and hull content. Quality, in other words, should determine its sale. This can only be accomplished by more careful grading, and by purchase on the basis of the grades.

C. C. BASS: *Emetin a Specific Remedy for Alveolodental Pyorrhea.*

Recent investigation has shown that an ameba, *Endameba buccalis*, is present in all lesions of alveolodental pyorrhea. There is abundant evidence indicating that this parasite is the specific cause of the disease. The endamebæ are in the very bottom of the pyorrhea pocket and burrow to some extent into the diseased tissue in search of certain cells which are the food of the parasite.

Emetin is so antagonistic to amebæ that it destroys most or all the endamebæ in a large percentage of cases, whenever given in the doses in which the present form may be employed—hydrochloride. In a considerable percentage of cases failure is met. The object of this paper is to make the suggestion that some other form of emetin may be prepared which can be used in larger doses, will cause less local irritation where injected, or perhaps may be more amebicidal than the hydrochloride.

CHAS. MANN: *Saw Palmetto, a Biochemical Study.*

The prime object of this investigation was to ascertain the facts relating to the formation of the so-called volatile oil in the fruit. The basis for this part of the investigation was laid by two experiments made by Professor J. U. Lloyd, one made in 1890, and the other started in 1890 but not completed until 1900.

The laboratory experiments have clearly demonstrated that the ethyl esters of the fatty acids, found in the berries both free and as glycerides, are not the product of biochemical processes of the plant, but are products formed after the fruits have been separated from the plant and have been preserved in a peculiar manner. It has also been demonstrated that the enzymes found in the fruit are not necessary to explain the formation of these esters which result by condensation without the intervention of enzyme or other so-called catalytic agent.

Most, if not all, of the other experiments grew out of this central problem. It is hoped that the manuscript will soon be published as one of the bulletins of the University of Wisconsin.

EMERSON R. MILLER and JEMISON MIMS MOSLEY: *Volatile Oils of Some Species of Solidago.*

Solidago rugosa Mill. The fresh flowering herb yielded 0.4 per cent. of oil which distilled mainly below 165°. Probably composed chiefly of the dextro- and levo-rotatory forms of a-pinene with smaller amounts of two other terpenes.

Solidago odora Ait. Average yield from the fresh flowering herb, 1.24 per cent. of oil. The chief interest here centers in the methyl chavicol which constitutes about 75 per cent. of the oil. Other constituents are: terpenes, 10–15 per cent.; esters, about 3 per cent. calculated as bornyl acetate; borneol and probably another alcohol, the total free alcohol being about 3 per cent., calculated as borneol; a small amount of volatile fatty acids, at least three; a small amount of non-volatile acid.

Emerson R. Miller: *Volatile Oils of Several Species of Eupatorium.*

Eupatorium capillifolium (Lamb.) Small. Of considerable interest owing to its abundance, yield of oil and especially its chief constituent, the dimethyl ether of thymohydroquinone, forming 50 to 60 per cent. of the oil. Other constituents: terpenes (20 to 25 per cent.), consisting of one or more phellandrenes and another terpene, probably *d*-*a*-pinene; borneol; bornyl acetate, other esters; acetic acid, other volatile fatty acids, probably butyric, valerianic and caproic; linalool (?); traces of salicylic acid and an unidentified white solid. Only two other plants known to yield above named ether.

E. Serotinum Michx. yield 0.4 per cent. Physical properties of oil indicate mainly sesquiterpenes.

E. perfoliatum L. Very small yield of a slightly bluish-green oil.

E. hyssopifolium L., *E. purpureum* L., yielded no oil by steam distillation.

Abstract from Bulletin No. 693, University of Wisconsin.

Emerson R. Miller: *The Volatile Oil of Achillea Millefolium* L.

Because of its beautiful deep blue color this oil is of interest apart from any practical value it may have.

In addition to the high boiling constituent the oil contains the following: *l*-*a*-pinene, *d*-*a*-pinene, *l*-limonene, *l*-borneol, *l*-camphor, cineol, two aldehydes, salicylic acid, acetic acid, two other volatile acids, at least one non-volatile acid, a high boiling compound and a compound of mint-like odor.

The blue constituent was obtained from both the leaves and flower heads, but is contained in very small amount in the former.

Submitted for publication as a University Bulletin, University of Wisconsin.

Emerson R. Miller: *Some Volatile Oils from the Genus Pycnanthemum.*

On account of their aromatic qualities this is a very attractive group of plants.

In the order named the yield of oil from the fresh flowering herb of the following species was 0.7–0.8 per cent; 1.2–1.38 per cent.; 0.5–0.7 per cent.

Pycnanthemum Tullia Benth. Constituents: *a*-pinene, a_D —46.7°, 15–20 per cent.: cineol, 50–60 per cent.; geraniol, linalool (?) together, 15–20 per cent.; salicylic acid; acetic acid and other volatile fatty acids; esters calculated as geranyl acetate, 1–2 per cent. The oil from a form of this species contained 50–53 per cent. of olefinic terpene alcohols, largely geraniol and 7–8 per cent. of ester calculated as geranyl acetate.

P. incanum (L.) Michx. This oil contained 90–92 per cent. of ketone, consisting largely, if not entirely, of pulegone.

P. lanceolatum Pursh. Constituents: carvacrol, 13–53 per cent.; geraniol, pulegone; probably also pinene and limonene.

Preliminary report.

W. J. V. Osterhout: *Artificial Photosynthesis by Means of Chlorophyl.*

If Schryver's test for formaldehyde is specific, experiments show that formaldehyde produced from chlorophyl acting in presence of carbonic acid in sunlight is due to the decomposition of the chlorophyl and not to photosynthesis, as has been supposed to be proved. Such other pigments as methyl green, iodine green and a variety of other stains, exposed to sunlight under the same conditions as chlorophyl, also give the test for formaldehyde. It seems probable that artificial photosynthesis by means of sunlight has not yet been accomplished.

W. E. Tottingham: *The Rôle of Chlorine in Plant Nutrition.*

Water cultures of various plants have shown marked stimulating effect of chlorides on root development. Sand cultures of mangel-supplied sodium and chlorine separately and combined have developed most favorably in the latter case. Soil cultures of sugar beet in the greenhouse-supplied sodium chloride have exceeded in yield control, unfertilized cultures. Other cultures receiving sodium nitrate, dicalcium phosphate and potassium chloride have produced greater yields than cultures receiving sodium nitrate, di-calcium phosphate and potassium sulphate. The percentage of sucrose in the dry matter has been increased also where the chlorine was added. Plot experiments in the field with sugar beet under the environment obtaining at Madison, Wis., have produced increased yields due to the application of sodium chloride. The increase in terms of sucrose has reached five hundred pounds per acre in excess of the control plots. It is purposed to extend this investigation to include a variety of plants and more than one cycle of growth and reproduction, in the belief that, with some plants at least, chlorine may be found to function in specific nutrient effects.

G. S. Fraps: *Nitrification Studies.*

The quantity of nitrates found in 334 soils after 12 weeks is, on an average, related to the total

nitrogen of the soil, but there are decided differences in individual cases. Cropped soils produce less nitric nitrogen than the same soil uncropped. Addition of calcium carbonate diminishes the individual variation, but does not eliminate it.

C. B. LIPMAN: *The Form of Nitrogen in Nitrogenous Materials as an Index to Nitrifiability.*

M. X. SULLIVAN: *The Formation of Creatinine by Bacteria.*

Whatever work has been done on the formation of creatinine by bacteria has been on media containing peptone. Peptone, however, is of animal origin and in itself contains antecedent bodies of creatinine and on slight hydrolysis with acid readily gives creatinine. In the present experiments it was found that a trace of soil added to a protein-free synthetic culture medium, with ammonium sulphate the source of nitrogen led to the development of a strong growth of bacteria. On analysis six months after inoculation of the media with the soil, creatinine was found by color reactions and by the formation of creatinine zinc chloride.

M. X. SULLIVAN: *The Amount of Creatinine in Plants.*

Several years ago the writer found that creatinine, as judged by color reactions and the formation of creatinine zinc chloride, occurred in plants. In the present work the quantity of creatinine was determined by Folin's colorimetric method. The determinations were made on the water-soluble part of the alcohol extract, after treatment with lead acetate, evaporation in vacuo, and taking up in absolute alcohol. Only a few parts per million (1–6) were found in the ungerminated seed of wheat and soy bean. The amount of creatine increased during germination. In wheat seedlings 10 to 12 days old from 40 to 65 parts per million of creatinine were found.

EDWARD GUDEMAN: *Toilet Papers, a Source of Infection.*

ADOLPH BERNHARD: *A Simple Colorimetric Method for the Determination of Free Reducing Sugars and Total Carbohydrate in Miscellaneous Food Products.*

The colorimetric method recently suggested by Lewis and Benedict for the sugar in the blood has been successfully employed, in slightly modified form, for the estimation of free reducing sugars in fruits, milk and a variety of food products. The method has also been utilized for the determination of the total carbohydrate in feces, tissues (glycogen) and in various food stuffs, especially diabetic foods.

For the determination of the free reducing sugars in fruit, a sample of the moist fruit is accurately weighed, ground in a mortar, made up to some convenient volume with water, and then sufficient dry picric acid added to make a saturated solution, precipitate traces of protein, etc. Two c.c. of the filtrate are now heated with 3 c.c. of 20 per cent. sodium carbonate for 10 minutes, diluted to 10 c.c. and compared with a standardized picramic acid solution. The total carbohydrate is similarly determined after hydrolysis and neutralization, the results showing excellent agreement with those obtained by the Allihn method.

JAMES P. ATKINSON: *The Reducing Action of Distillates from Certain Carbohydrates on Distillation with Steam and from Alkaline Solution.*

An alkaline solution, containing glucose, under the conditions imposed in water analysis gave a greenish yellow color in the Nessler reagent, increasing in depth until precipitation of the reagent occurred. S. and S. filter paper No. 589, the purest samples purchasable of saccharose, lactose, grape sugar, levulose, maltose, mannose, dextrin, and soluble starch, similarly treated in water free from ammonia, or in presence of sodium carbonate, gave a yellow color with Nessler reagent, and, finally, in all cases except saccharose, reduced the reagent to metallic mercury. Evidently, the presence of carbohydrate may be confused with the presence of ammonia indicated by the Nessler reagent. In water analysis, in urine and in blood tests this fact should be regarded.

SARA STOWEL GRAVES: *A Precipitant for Ammonia.*

A reagent consisting of 130 c.c. of water, 80 g. of sodium chloride, 100 c.c. cold saturated mercuric chloride and 70 c.c. of cold saturated solution of lithium carbonate, was found as sensitive as Nessler's reagent. With the nephelometer this reagent was found to show ammonia in ammonium sulphate solutions as dilute as 0.00001 per cent. Soluble starch, prepared by boiling 1 g. of starch until clear, then diluting to 100 c.c., held the precipitate in suspension the ten to thirty minutes necessary in nephelometric readings. Tests were made on a standard ammonium sulphate solution, made according to Folin's directions. The solution was found to give satisfactory results with ammonium sulphate alone, with ammonium sulphate in presence of filter paper, with uric acid, and with urine, in water analysis, in normal and micro Kjeldahl determinations. This new reagent for ammonia is as sensitive as Nessler's reagent

and more stable than Nessler's reagent. It will precipitate ammonia quantitatively and will give accurate results nephelometrically.

W. Denis: *Phenols and Phenol Derivatives in Urine.*

J. H. Long: *On the Physiological Activity of Combined Hydrochloric Acid.*

This paper discusses the behavior of betain hydrochloride and glutaminic acid hydrochloride, on the one hand, and certain protein compounds of hydrochloric acid, on the other, toward pepsin in digestion. The hydrochlorides of amino acids, and a number of similar bodies, are active in promoting the peptic digestion of proteins in proportion to the ease with which the acid dissociates in aqueous solution. In this respect the behavior of betain hydrochloride is more marked than is that of the glutaminic acid hydrochlorides or the hydrochlorides of other amino acids, although the acid appears to be active in all these bodies.

The hydrochloric acid in combination with protein is much less readily dissociated, and therefore much less active. The amount of acid which may be combined with protein is not sufficient to digest much more than the protein united with it. For real digestion there must be some excess of actual acid, the hydrogen ion concentration of which may be determined. The hydrogen concentration of a number of mixtures of varying degrees of digestive activity is given.

J. H. Long: *On Combinations of Proteins with Halogen Acids.*

It has been long known that proteins and acids combine in certain proportions, but all the conditions of combination are not so clearly known. The halogen acids and the halogens themselves combine in very different ways. In this paper combinations between casein, fibrin and egg albumin, on the one hand, and hydrochloric, hydrobromic and hydriodic acids, on the other, are discussed. It is shown that the rapidity of combination depends on several factors, as concentration of acid, temperature or agitation of the mixture of protein and acid. Tables are given showing variations with these factors.

The amount of either acid which may be combined with the proteins soon reaches a constant maximum value by elevation of temperature, and is relatively greatest with hydriodic acid. But because of the ready decomposition of this acid it is difficult to distinguish between the union with the acid and the substitution of the element itself. The weights of the acids combined do not seem to be proportional to the molecular weights of the acids. For each of the acids the amount which may be held by a given protein decreases in the order, egg, fibrin, casein. The reactions with hydrochloric acid are very sharp, and with hydrobromic acid fairly so, but with hydriodic acid the reducing action obscures the other to a marked degree.

Chas. Baskerville: *On the Rate of Evaporation of Ether from Oils and Its Application in Oil-ether Colonic Anesthesia.*

The rate of evaporation of oil-ether mixtures containing 25, 50 and 75 per cent. of the latter was determined at body temperature. The oils used were olive, peanut, corn, cottonseed, soya bean, codliver and lanolin.

The speed at which the ether evaporated from the 75 per cent. mixture was found clinically to be the best for introducing and maintaining anesthesia in the human by insertion in the colon. The technique is indicated for operations about the head, throat, mouth and the buccal cavity.

Dr. Gwathmey, the senior collaborator, has records of over a thousand cases with different operators without a single case of post-anesthesia pneumonia and with nausea reduced to the minimum.

H. S. Grindley and E. C. Eckstein: *The Free Amid Nitrogen and the Free Amino-acid Nitrogen of Feedingstuffs.*

The free amid nitrogen of tankage, alfalfa hay, and blood meal formed 0.84, 0.63 and 0.16 per cent., respectively, of the total nitrogen of the feedingstuff.

The free amino-acid nitrogen of tankage, alfalfa hay, and blood meal formed 3.08, 2.87, and 0.36 per cent., respectively, of the total nitrogen of the feedingstuff.

The free amid nitrogen and the free amino-acid nitrogen combined accounted for only one seventh to one fourth of the total nitrogenous substances present in the free amid and amino-acid extract of these three feedingstuffs.

H. S. Grindley, W. E. Joseph and M. E. Slater: *The Quantitative Determination of the Amino-acids of the Mixed Proteins of Feedingstuffs.*

The Van Slyke method has been applied to the quantitative estimation of the amino-acids of the mixed proteins of feedingstuffs. While there are marked variations in the amino-acid content of the mixed proteins of feedingstuffs expressed in per cent. of the total nitrogen of the feedingstuff, the variations are not as great, as a rule, as those for the individual proteins. The results show that

the amino-acid content of the mixed proteins expressed in per cent. of the feedingstuff varies quite markedly.

R. S. POTTER and R. S. SNYDER: *Nitrogen Distribution According to the Van Slyke Method in Soils and their Humic Acids.*

R. S. POTTER and R. S. SNYDER: *Amino Acid Nitrogen in Soils Variously Treated.*

MAX KAHN: *A Study of Urinary Mucin.*

MAX KAHN and F. G. GOODRIDGE: *On Cystine.*

F. G. GOODRIDGE: *Biochemical Studies of Mercaptan.*

MAX KAHN and FRANCIS HUBER: *Metabolism Studies of Multiple Myeloma with Bence-Jones Albumose.*

MAX KAHN and S. SCHNEIDER: *Study of the Mineral Metabolism of Diabetics.*

A. F. HESS and MAX KAHN: *Mineral Metabolism of Two Cases of Hemophilia.*

JACOB ROSENBLOOM: *A Study of the Ethereal Sulfates of the Urine in Various Diseases.*

JACOB ROSENBLOOM: *A Modification of Gerhardt's Test for Diacetic Acid.*

JACOB ROSENBLOOM: *The Influence of Low and High Protein Intake on the Excretion of Acetone, Diacetic Acid, and Beta-oxybutyric Acid in Diabetes.*

WILLIAM MANSFIELD CLARK: *On the So-called "Reaction" of Bacteriological Culture Media.*

By means of titration curves in which the quantity of acid or alkali added to a medium is plotted against the resulting hydrogen ion concentration it is shown that:

I. There can be no true "end point" with phenolphthalein in the titration of culture media.

II. The amount of alkali which must be added in order to reach an arbitrary tint of phenolphthalein is a function of the buffer effect of any particular medium.

III. The so-called correction of the reaction by the addition of a fraction of the amount of alkali required to reach an arbitrary tint of an indicator may result in very different hydrogen ion concentrations in different media.

The practise of titrating media while hot is shown to give no precise data in regard to the reaction of a cold medium.

The fallacies of the titrimetric method of adjusting the reaction of culture media are summed up and it is concluded that the colorimetric method of adjusting to a desired hydrogen ion concentration is more logical.

WILLIAM MANSFIELD CLARK: *The Final Hydrogen Ion Concentrations of Cultures of B. Coli.*

The conclusion of Michaelis and Marcora that the fermentation of sugars by *B. coli* is limited by a definite hydrogen ion concentration rather than by the molecular concentration of the acid produced was confirmed in its essentials by studies with seventeen organisms cultivated in thirty different media. There were, however, minor but noteworthy differences in the final hydrogen ion concentrations attained in different media. These differences were related to the magnitude of the "buffer effect" of the different media.

It is pointed out that the determination of the final hydrogen ion concentration furnishes comparable data where the determination of titratable acidity can not.

E. H. WALTERS and WM. M. CLARK: *The Relation between the Propionic Bacteria and Eye Formation in Emmental Cheese.*

A careful study of pure active cultures of *Bacillus propionici* isolated from emmental cheese has shown that the Fitz equation

$$\underset{\text{lactic}}{3C_3H_6O_3} = \underset{\text{propionic}}{2C_3H_6O_2} + \underset{\text{acetic}}{C_2H_4O_2} + CO_2 + H_2O$$

represents the relation of the end products in a pure fermentation of lactic acid. Experiments are described in detail which show that the carbon dioxide produced in a fermentation of this kind is entirely inadequate to explain the formation of eyes in emmental cheese as proposed by Freudenreich and Jensen since the amount of carbon dioxide produced in cheese is greatly in excess of the amount which could be accounted for in this way.

S. L. JODIDI: *On the Factor to be Used for the Calculation of the Phosphoric Acid in Neumann's Method.*

S. L. JODIDI and E. H. KELLOGG: *On the Factor to be Used for the Calculation of Phosphoric Acid in Neumann's Method. I. The Factor as Influenced by the Water Used for Washing the Yellow Precipitate.*

ROBERT E. SWAIN and E. R. HARDING: *The Quantitative Estimation of Alantoin.*

LEWIS KNUDSON: *The Influence of Certain Sugars on the Growth and Respiration of Vetch.*

An extensive investigation has been made on the direct absorption of various sugars by vetch (*Vicia villosa*). Plants were grown for the most part on agar nutrient media in large cylinders under sterile conditions. The results indicate that vetch is able to absorb and utilize saccharose, glu-

cose, levulose, maltose and lactose. Galactose (Merck's highest purity) is toxic at 2 per cent. and even less. In both 2 per cent. solutions and 0.5 molecular solutions the order of assimilability of the sugars is saccharose, glucose, levulose, maltose and lactose. Sugars increase the growth, increase respiration (evolution of CO_2). Experiments with saccharose indicate also that the roots secrete the enzyme invertase into the culture medium or that reducing sugars are excreted by the roots of plants grown therein. This latter phase is now receiving particular attention.

W. J. Robbins: *The Influence of Certain Inorganic Substances on the Digestion of Starch by Penicillium camembertii.*

The growth of *Penicillium camembertii* and the digestion of starch by the same fungus was determined in nutrient solutions which lacked one of the elements usually considered essential for the fungi. The growth of the same fungus and its digestion of starch in the presence of M/1,000, M/10,000 and M/100,000 concentrations of the chlorides, sulphates, nitrates and dihydrogen phosphates of Na and K and the chlorides, sulphates and nitrates of Ca and Mg was determined. It is believed that the results indicate an intimate relation of nitrogen to diastase formation and that the neutral salts in concentrations as weak as M/100,000 affect the secretion of diastase.

William Mansfield Clark and Herbert A. Lubs: *The Differentiation of Bacteria of the Colon-aerogenes Family by Means of Indicators.*

By means of the hydrogen electrode the acid production, in terms of hydrogen ion concentration, of bacteria of the colon-aerogenes family has been followed. The two groups differentiated by Rogers Clark and Davis by the gas ratio were found to differ in their acid production in such a way that under an established set of conditions the final hydrogen ion concentrations could be made to differ widely. The difference in the final hydrogen ion concentration can be made so distinct that it can be easily detected by the proper indicator, either p-nitro phenol or methyl red. The test was shown to correlate perfectly with the gas ratio, and proved to be so simple that it is adapted for routine use.

C. O. Johns and Arno Viehoever: *The Saponins of Chlorogalum pomeridianum and Agave lechiguila.*

The dried bulb of *Chlorogalum pomeridianum* from California, known as California soap root, gave on extraction and purification a powder, which by combustion indicated the formula, $C_{51}H_{86}O_{28}$, for this saponin, the molecular weight of which is 1,146. Molecular weight determinations with phenol as solvent gave 1,101 and 1,146. The dried rootstock and underground yellow parts of the leaves of *Agave lechiguilla* from Texas, similarly treated, gave a saponin, the combustion of which indicated the formula, $C_{25}H_{42}O_{14}$, corresponding to the molecular weight 566. The molecular weight with phenol as solvent was 606 and 616. Both saponins gave the saponin reactions. Aqueous solutions of 0.01 per cent. of saponins were lethal in a short period of time for minnows.

C. O. Johns and Arno Viehoever: *On the Alkaloids of Amianthium muscetoxicum (Fly Poison).*

Leaves and bulbs of *Amianthium Muscetoxicum* were extracted separately from plants gathered in March and from plants gathered in May of last year. More alkaloid was found in the leaves than in the bulbs. More alkaloid was found in the specimens gathered in March than in those gathered in May. Thus far two crystalline alkaloids have been isolated, one crystallizing in needles and melting near 220° C. with effervescence, and the second crystallizing in prisms and melting near 200° C. The physical properties and melting points show that neither of these is zygadine, recently isolated from *Zygadenus intermedius* by Heyl and his collaborators. These alkaloids were soluble in the common organic solvents, but only slightly soluble in water.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

Geo. P. Adamson, *chairman*

S. H. Salisbury, Jr., *secretary*

Alexander Silverman: *The Chemists' Corporation: A Plan to Make Research Possible and Enable the Chemist to Profit by the Results.*

The plan proposed is partly of the nature of a cooperative society, partly a corporation. It is the writer's feeling that chemists who have money to invest shall purchase shares in the corporation; that the funds of the corporation shall be controlled by a committee of capable chemists and business men selected by the various scientific societies; that any chemist submitting plans for research to this committee may have funds advanced to conduct the investigation, providing the committee deems the idea valuable. In case of success the committee may either finance the manufacture or conduct negotiations for the manufacture by a company on such a basis that the chem-

ist shall receive a fair share of the profits. A certain per cent. of the profits shall revert to the corporation and the experimenter shall return all moneys advanced, with interest.

The researches can be conducted at universities or at some of the industrial research laboratories available. Shareholders should receive a fair return on their investment and the balance of profits should be placed in a surplus fund or used to further subsidize research.

The chemist has made many valuable contributions to the industries and has, only too often, been left both without recognition and proper financial return. Industrial research laboratories have bettered his lot considerably, but this plan, with their cooperation and the cooperation of chemists who have already succeeded financially should go a step farther in giving him the recognition he deserves.

WILLIAM M. BOOTH: *The Chemist and Industrial Water Purification.*

W. C. HANNA: *What the Chemist Has Done for the Portland Cement Industry in the United States.*

FREDERIC DANNERTH: *The Industrial Chemist in His Relation to Fire Prevention.*

The total fire loss in the United States and Canada, including forest fires, has averaged 231 million dollars per year for the past five years. Since the beginning of this century we have lost over three billion dollars' worth of property. The per capita fire loss in the United States is $2.55 as compared with 84 cents in France and 20 cents in Germany. In 1914 the eleven largest fires in chemical industries showed a property loss of 7½ million dollars. As a result of this the industrial chemist has now begun to study the causes of fires in order that he may remove the source, if possible, and he is studying such materials as rubber-lined fire hose so that, after a fire has once started, the fight against it may be conducted more efficiently.

A. LOWENSTEIN and J. J. VOLLERTSEN: *The Influence of Free Fatty Acids on the Flash and Fire Points of Fats and Oils.*

A. LOWENSTEIN and J. J. VOLLERTSEN: *The Influence of Pyridine on the Ammonia Determination of Concentrated Ammoniacal Liquor.*

EDWARD HART: *The Potash Supply.*

Methods unfitted to meet ultimate German competition are those which turn out only potash. This is true because the first cost of the German material is extremely low.

Among processes which are more likely to succeed are:

First, the condensed potash from cement kilns, the obtainable supply of sulphate from this source being placed at not more than 60,000 tons; second, from feldspar refuse, as in the Hart process, where the products are a white pigment containing barium sulfate and gelatinized silica alum and aluminum sulfate. If the alum be unsalable as such it may cheaply be converted into potassium and aluminum sulfates.

G. A. RANKIN: *The Constituents of Portland Cement Clinker.*

From the results obtained during a systematic study of the system $CaO\text{-}Al_2O_3\text{-}SiO_2$, we have found that these three oxides *alone* in the proportions in which they occur in commercial portland cement when perfectly burned will produce a clinker made up only of the constituents (compounds) $2\ CaO \cdot SiO_2$, $3\ CaO \cdot SiO_2$ and $3\ CaO \cdot Al_2O_3$. This clinker possesses all the properties of a desirable portland cement, when it is ground and treated with water.

White commercial portland cement has a CaO, Al_2O_3, SiO_2 content of over 95 per cent., while the more common gray variety of cement contains over 90 per cent. of these three oxides. Examinations of the clinker of these two types of cement have shown that the main constituents (over 90 per cent.) are $2\ CaO \cdot SiO_2$, $3\ CaO \cdot SiO_2$ and $3\ CaO \cdot Al_2O_3$, and that the minor constituents (less than 10 per cent.) are $5\ CaO \cdot 3Al_2O_3$, CaO, and ferrites.

It may, therefore, be definitely stated that portland cement clinker is made up largely of the three CaO, Al_2O_3, SiO_2 compounds, $2\ CaO \cdot SiO_2$, $3\ CaO \cdot SiO_2$ and $3\ CaO \cdot Al_2O_3$ and it seems probable that the desirable properties of portland cement are due to presence of these three major constituents and that the minor constituents have little, if any, influence.

GEORGE K. BURGESS and P. D. SALE: *A Study of the Quality of Platinum Ware with Special Reference to Losses on Heating.*

A thermoelectric survey of the purity of 164 platinum utensils has been made and 14 crucibles were subjected to a systematic heating and acid washing treatment to determine losses in weight. Heating losses, which are least for platinum crucibles containing rhodium and increases with iridium content, range from 0.71 to 2.69 mg. per hour per 100 $cm.^2$ at 1,200° C. Suggestions are offered as to specifications for platinum ware, and it is shown that losses on heating may be predicted from thermoelectric and microscopic examinations for iron-free crucibles.

J. B. Tuttle and A. Isaacs: *A Study of Some Recent Methods for the Determination of Total Sulphur in Rubber.*

This investigation was undertaken to learn whether or not the methods recently published for the determination of sulphur in rubber were any improvement over the Waters and Tuttle method, the one now in use at the Bureau of Standards.

The methods compared were divided into two classes, viz., those for the determination of the total sulphur and those for the determination of sulphur other than that present in the insoluble sulphates. It was found that the methods of the second class could not be relied upon to give accurate results. The Waters and Tuttle method was found to give satisfactory results, and is recommended for general use.

The free sulphur was found to be the most troublesome factor, and a new method is given which eliminates this difficulty.

E. R. Weaver and J. D. Edwards: *Gas-washing Apparatus with Enclosed Filter.*

Three forms of gas-washing apparatus are described, which give thorough circulation of the liquid, efficient washing and which operate under low inlet gas pressure. If a precipitate is formed it may be filtered off and washed without coming in contact with the air.

E. R. Weaver: *A Simple Stone-frame Chemical Hood.*

Two chemical hoods are described, one with and one without doors. The hoods are light, simple, resistant to chemical action, and easily cleaned and ventilated.

E. R. Weaver and J. D. Edwards: *Apparatus for Determination of Sulphur in Gas.*

A simple apparatus for determining sulphur in gas is described. The gas is burned in a straight glass tube, from which the products of combustion are drawn through a suitable absorbent. The burner consists of a porcelain tube, the gas being ignited at the tip, by a spark between platinum terminals sealed to the burner tube. The air necessary for combustion is regulated by suitably placed cocks on the inlet tubes.

E. W. Boughton: *The Determination of Oil and Resin in Varnish.*

The proposed method includes saponification of the varnish, separation of unsaponifiable matter, and separation of fatty acids from resin acids by the Twitchell or Wolff methods of esterification. A correction is applied for resinous matter that is weighed as fatty acids. Oil and resin can not be separated by treating varnish or oxidized varnish with solvents such as petrolic ether or chloroform. Resinous matter is only partially precipitated by petrolic ether. Determination of glycerol yield and calculation of oil content therefrom is not satisfactory. Proposed method gives results for resin content which are within 5 per cent. of the amounts present.

W. O. Mitscherling: *Tetrephosphorus Trisulfide.*

H. A. Huston: *The German Potash Industry.*

The potash industry includes about 200 operating mines and about 50 in course of construction. Only the more favorable locations have been developed. Enormous deposits below the 5,000-foot level are untouched and the whole polyhalit region which contains nearly as much soluble potash as the carnallit region, and is reached by the existing shafts, is not worked at all for potash.

The United States use about one fourth of the total production of the potash mines, being the main consumers of concentrated salts. The total amount of material mined annually is about 11,000,000 tons. The United States use 260,000 tons of actual potash contained in about 1,250,000 tons of the various products which we purchase. Of this about 95 per cent. is used in agriculture and five per cent. in chemical industries other than fertilizer factories. The potash used in American agriculture increased 277 per cent. from 1900 to 1910. That used in chemical industries increased about 20 per cent. Potash used in the chemical industries in the United States for the years 1911, 1912 and 1913 averaged 38 per cent. more than that used in 1910.

The war has caused a great increase in the cost of producing potash because of advances in cost of labor, fuel and explosives. Freight to the ports used was much higher than to the usual ports. The $4 per ton increase in price delivered at American ports by no means covers the additional cost previous to putting on shipboard. The increase in ocean freight is always at the expense of the seller, never at the expense of the American buyer. The buyer pays for special war insurance if he elects to use it. Any increase in price in excess of $5 per ton represents profit to the American potash importers.

Potash stocks in the American warehouses of the German Kali Works at the outbreak of the war were turned over to American buyers at regular list prices.

(*To be continued*)

Charles L. Parsons,
Secretary

SCIENCE

FRIDAY, JULY 16, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

INVESTIGATIONS AT THE NUTRITION LABORATORY OF THE CARNEGIE INSTITUTION OF WASHINGTON, BOSTON, MASSACHUSETTS[1]

CONTRARY to popular opinion the researches of the Carnegie Nutrition Laboratory do not follow for the most part the conventional lines of "nutrition investigations" with special emphasis upon the economic and sociological phases of the work. The admirable facilities and equipment of the United States Department of Agriculture fortunately make this unnecessary. The Carnegie Laboratory is, however, an outcome of the national nutrition investigations, for the late Professor W. O. Atwater, who was a pioneer in nutrition investigations of this country, wisely devoted a part of the government appropriation for nutrition investigations to an abstract study of the physiological effects of various nutrients upon the human body. This work was carried out in the chemical laboratory of Wesleyan University, Middletown, Conn., and resulted in the construction of a special form of apparatus for studying both the respiratory products and the direct heat production of man, an apparatus properly designated by Professor Atwater as a "respiration calorimeter." Subsequently the board of trustees of the Carnegie Institution of Washington authorized the construction of a special laboratory for similar research in Boston.

It was believed that the appropriation for this laboratory, for a time at least, could best be subdivided into three main

[1] An address delivered before the department of chemistry at Vassar College, Poughkeepsie, New York, on May 10, 1915.

categories: First, the development of new apparatus and technique, thus insuring progress in technical lines; second, the accumulation of normal physiological data regarding the metabolism and many physiological factors of both men and animals, such research being needed to supplement the insufficient data secured in previous investigations; and third, the comprehensive, critical study of certain pathological cases, notably diabetics. In connection with the first of these lines of work there has been not only the development of a large amount of apparatus—for the greater part of the apparatus used in the nutrition laboratory has been there devised and constructed—but also an extensive comparison of other methods in regular use, to determine their degree of accuracy and applicability.

The laboratory building is of special construction, the main feature being the large room devoted to calorimetric researches. With so delicate an apparatus as the calorimeter, the effect of temperature environment is profound, and consequently this room is provided with heating and cooling devices by which the temperature may be held constant. Researches with this apparatus may therefore be conducted at any time of the year without regard to the prevailing temperature.

As at present equipped, the calorimeter laboratory has four calorimeters, all of which may be used for studying the heat production of the human body. Of these the bed calorimeter has been most extensively used for studying normal men and women as well as in a long series of experiments with severe diabetics. The inner chamber of this apparatus is copper-walled and about 7 feet long and 3 feet wide, varying in height from 2 feet at the foot to about 3½ feet at the head. The subject, lying comfortably on a mattress, is slid into this chamber and the opening closed with a large piece of plate glass, the closure being made airtight by sealing with wax. The ventilating current draws the air from this chamber, forces it through sulphuric acid to remove the water vapor given off by the lungs and skin of the subject, and then through soda lime to remove the carbon dioxide. After pure oxygen has been added to replace that used, the air returns to the chamber to be rebreathed by the subject. By weighing the soda lime containers at the beginning and end of the experiment and metering the oxygen admitted, we have a direct measure of the carbon dioxide produced and the oxygen consumed. This is the respiratory feature of the apparatus.

The method of measuring the heat production is of particular interest. The inner chamber or copper box is surrounded by several layers of material which provide good insulation. Outside of this copper box are two supplementary walls, the first of zinc and the second of a one-inch layer of cork. These walls are in each case three inches from the inner wall, providing two dead air spaces between the copper and the zinc and the zinc and the cork, respectively. The outside of the calorimeter is finished with compo board. Thus, the apparatus is of the refrigerator type of construction, effectually preventing heat radiation. In winter, houses are heated by passing hot water through pipes. This small chamber, or little house, would, unless cooled, become uncomfortably warm from heat given off by the body, and provision for cooling is made by passing a current of cold water through the chamber in fine serpentine copper pipes. The temperature of the water is recorded as it enters and leaves the chamber. If the total weight of water leaving the apparatus is measured the heat brought away is readily computed by multi-

plying this weight by the temperature difference.

The chair calorimeter is of a different shape, although primarily of the same construction. In the chair calorimeter, the subject sits in a comfortable arm chair, the walls of the chamber being of such a form as to give a minimum amount of air space about the body. The total volume of air space in the bed calorimeter is 950 liters, and in the chair calorimeter 1,500 liters. Neither apparatus, however, permits long experiments.

A third calorimeter has been built which is long enough for a man to lie down in, and yet high enough for him to stand up; the form of the chamber also permits the installation of a bicycle ergometer inside the chamber for muscular work experiments. The volume of air space in this apparatus has been limited to 3,500 liters. By means of a double port-hole it is possible to put in or take out food or other material without loss of air. The subject can live in this apparatus as long, if not longer, than in the chamber at Wesleyan University, Middletown, Conn., the longest experiment with that apparatus covering 13 days and 14 nights. Thus far no continuous calorimeter experiments of any considerable length have been made in the Nutrition Laboratory.

Finally, to provide a calorimeter especially designed for severe muscular work with a bicycle ergometer, treadmill, or endless ladder, a calorimeter has been built with provision for installing any one of these muscular work appliances. Owing to the great amount of heat that will be developed in such experiments, special heat-absorbing pipes and temperature measuring apparatus have been necessary.

With the respiration calorimeter it is possible to measure simultaneously the carbon dioxide and water vapor produced, the oxygen consumed, and the heat given off by a man. These factors taken not only individually, but also together, give most important data for the computation of the character and amount of the interchange of material inside of the body due to vital processes.

Fortunately it was found that the long and costly twenty-four-hour calorimeter experiments could be in part replaced by shorter experiments, in which only the carbon-dioxide production and oxygen consumption were studied, by means of a respiration apparatus devoid of calorimetric features and that this type of short experiment could be used in the study of many problems. An apparatus was devised by which a subject lying on a bed could breathe through a mouth- or nosepiece, and determinations of the carbon dioxide produced and the oxygen consumed could be made in periods as short as 15 minutes. These experiments have been carried out very rapidly and at relatively slight expense, and have been of great value in giving us a large amount of important physiological information. In recent years, the calorimeters have also been used for short experiments, these being from one to two hours long; indeed, the research on diabetes, which has been in progress in the Nutrition Laboratory for the past six years, has relied for the most part on calorimeter experiments of from one and one half to two hours' duration.

The influence of muscular activity upon the production of carbon dioxide and heat is enormous. When a subject is sound asleep, quiet and without food in the stomach, we have the minimum basal metabolism. The influence of sleep has only been tardily recognized, and the majority of physiologists are inclined to speak of basal metabolism as that obtained in the early forenoon, when the subject is lying

quietly without breakfast, but not asleep. If the subject is sitting up, the metabolism is increased, and if he is doing work it is increased in proportion to the amount of work. The approximate normal output of carbon dioxide and heat for a man of average weight with varying conditions of muscular activity is shown in Table I. By means of this table one may calculate the approximate carbon dioxide and heat output of a man during twenty-four hours. (See Table II.)

TABLE I

Average Normal Output of Carbon Dioxide and Heat from the Body

Conditions of Muscular Activity	Average Quantities Per Hour: Carbon Dioxide, Gm.	Heat Cals.
Man at rest, sleeping	25	65
Man at rest, awake, sitting up	35	100
Man at light muscular exercise	55	170
Man at moderately active muscular exercise	100	290
Man at severe muscular exercise	150	450
Man at very severe muscular exercise	210	600

TABLE II

Average Daily Output of Heat of a Man at Light Muscular Work

Daily Program	Heat Output
At rest, sleeping, 8 hours, 65 calories per hour	520
At rest, awake, sitting up, 6 hours, 100 cal. per hour	600
Light muscular exercise, 10 hours, 170 cal. per hour	1,700
Total output of heat, 24 hours	2,820

It is of no avail to make investigations in pathology unless we have a suitable base line or ground for comparison, and in practically all our clinical studies we have had to supply the deficiency in normal data. While the temptation is at times very great to carry out a series of experiments which will most certainly promise striking results, we have felt constrained to plod along and secure fundamental basal values, and thus contribute steadily to the knowledge of the physiology of man. To do this, and to secure information as to the influence of variations in height, age, weight and sex of normal individuals, we have studied 90 or more normal men, and nearly as many normal women, and have secured approximate basal values for these individuals. Studies have likewise been made of athletes and vegetarians. For the most part these observations were made with the small respiration apparatus and not with the calorimeters; indeed, at times as many as four respiration apparatus have been used simultaneously in our large calorimeter room, in studying the metabolism of four individuals.

Two factors that affect normal metabolism more than any others are the ingestion of food and muscular activity. In Table I., the somewhat vague terms of "light," "moderately active," "severe" and "very severe" muscular work were used. These really have no quantitative meaning, and it is necessary for us to measure accurately the amount of mechanical work performed when studying the metabolism of a person doing severe muscular work. For this purpose several forms of bicycle ergometer have been used by means of which the rider transforms a certain amount of muscular work into heat. The ergometer may be placed inside a respiration calorimeter, or the subject may be connected with a suitable mouthpiece to a simple respiration apparatus. The series of studies on this apparatus have proved most illuminating, and show that the human body is really a very efficient engine. While in certain cases as much as 35 per cent. of the total energy transformed during muscular work may be transferred to the pedals of the ergometer, there to be transformed into

heat, the average values obtained were those given in Table III.

TABLE III

Experiments on Bicycle Riders (Calories per Hour)

	Resting	Working	Work Done	Efficiency, Per Cent.
J. C. W. (college athlete)	112	339	49	21.6
B. F. D. (college athlete)	106	318	45	21.2
A. L. L. (untrained)	—	326	46	20.8
E. F. S. (untrained)	?	399	51	18.1
N. B. (professional rider)	92	619	112	21.3
		471	79	20.8
		401	65	21.0
		382	60	20.7

The figures in Table III. shed a most interesting light on the question of training. It has commonly been supposed that when a person is trained, the muscles become more effective and consequently there is a greater production of work for the same expenditure. Here we find that in the first place the two men, A. L. L. and E. F. S., who were wholly untrained, and indeed wholly unfamiliar with the bicycle, accomplished as much work as did the college athletes, J. C. W. and B. F. D., with an efficiency very little less than that of the first two. When we examine the results obtained with the professional bicycle rider, Mr. Nat Butler, we find that he was able by virtue of his strength to accomplish a very great deal *more* work than any of the other men, but as a matter of fact his *efficiency* was not materially greater than that of the college athletes, or, indeed, the untrained men.

In order to produce this heat in the body there must have been vigorous combustion, either of body substance, in case the subject did not have food enough, or of food material previously eaten. We have found as a result of a large number of experiments that a man at rest, doing no visible external muscular work, requires not far from 2,000 calories for maintenance during twenty-four hours. It will be seen that in three hours Mr. Butler produced nearly this amount when at severe muscular work; consequently he must have burned up in these three hours as much material as would ordinarily be burned by a subject at rest in twenty-four hours. On this same basis, he would need three meals every three hours or one square meal an hour.

A new series of muscular work experiments is in progress in the Nutrition Laboratory under the direction of Professor H. M. Smith in which the subject walks on a specially-designed treadmill at varying rates of speed, breathing through a mouthpiece into a respiration apparatus which measures the carbon-dioxide excretion and the oxygen consumption. As a result of this investigation it has been found that in walking on a level road at a moderate gait (70 to 80 meters per minute) there is an increase in the heat production for each kilogram of body weight moved forward one meter, which is equivalent to about 0.5 small calorie. With an increase in velocity the energy expenditure is rapidly augmented and during running may become 60 per cent. more per unit of weight transported than that of the subject walking at a moderate rate. Studies are also being made with this treadmill in which the subject walks on an incline, the work of ascent thus being added to the work of walking on a level.

In this investigation, which is elaborate, a large number of simultaneous measurements have been attempted. In addition to measurements of the carbon-dioxide excretion and the oxygen consumption, we

have simultaneously recorded the total distance walked, the number of steps, the inclination of the treadmill and the total height of the body movement. By attaching a cord to the shoulders and connecting it with a pointer, a record of the up-and-down motion of the body with each step is made, and by a multiplying device the total sum of the upward motions of the body are also recorded, thus giving the total height to which the body is raised during the period of walking, for in walking on a level plain, an individual raises his body from 1 to 1½ inches each step.

Connected with the ventilating air current of the respiration apparatus is a delicately-counterpoised bell or gas-holder, which rises and falls with each respiration. By means of a pointer attached to the counterpoise of this bell, a graphic record of the type of respiration is obtained. A multiplying device attached permits the measurement of the total amount of air actually passing through the lungs independent of the ventilation of the respiration apparatus itself. This graphic record of the ventilation of the lungs likewise records the respiration rate. Finally, by means of electrodes attached to the chest, the pulse rate of a walking man is photographically recorded with a string galvanometer or an oscillograph.

The intimate relationship between pulse-rate and the total energy output has been the subject of special study, and the pulse-rate, the respiration-rate, and particularly the body temperature have received especial attention in our several lines of investigation. The distribution of a number of delicate thermometers in different parts and cavities of the body has shown that when the temperature deep in the body trunk undergoes its regular daily rhythm, these fluctuations in temperature are accompanied by similar fluctuations in all the other thermometers, and that while the absolute temperatures in different parts of the body are unlike, the fluctuations in temperature are essentially the same throughout the whole body.

It has long been known that when food is eaten the body activities are considerably increased. This is particularly the case when the food consists of protein material. The exact cause of this increase has long been the subject of much discussion. On the one hand it was believed that this was due to the work of digestion in the digestive tract; on the other hand, that it was due to an excess heat production caused by the splitting off and combustion of portions of the protein molecule. A long series of investigations in the Nutrition Laboratory has shown that when peristaltic stimuli, such as saline purgatives, were used and careful control tests made, the movements of the digestive tract did not measurably increase the metabolism. When dogs who had deficient digestive capacity were fed large amounts of meat, in spite of the excess of undigested residue, the metabolism was not augmented. Evidence has been accumulated which shows that the acid products of cleavage in the processes of digestion are probably the chief factors causing this increase in metabolism, which was explained by the direct stimulus of the cells to a greater activity.

One of the most interesting researches developing from the comparison of methods for studying the respiratory exchange has been the importance of knowing physiologically the exact composition of outdoor air. Every person is continually taking air into the lungs. Many technical methods for determining the amount of oxygen thus consumed involve some assumption as to the exact composition of the normal outdoor air inhaled. An investigation lasting over three years, in which daily analyses of

outdoor air were made by Miss Alice Johnson, proved conclusively that the percentage of carbon dioxide and oxygen in uncontaminated outdoor air remained constant throughout the entire year, irrespective of wind direction and temperature. Specimens of normal air secured at numerous places on the Atlantic Ocean and on the top of Pike's Peak showed the same remarkable uniformity. By this study we were provided at one and the same time with a standard for testing all gas-analysis apparatus and definite knowledge regarding the composition of inspired air, thus doing away with the necessity for the innumerable analyses that otherwise would be essential.

The investigations on diabetes in conjunction with Professor Elliott P. Joslin have shown in the first place that during severe diabetes there is a distinct increase in the basal metabolism of the patients. It has also been shown that this increased metabolism in diabetes is due to the fact that with the abnormal breaking down of food materials in the body of the diabetic there is developed an excessive amount of acid, chiefly B-oxybutyric acid, which directly stimulates the cells to a greater activity. With treatment reducing the acidity and particularly with the new, remarkable Allen treatment this increased metabolism entirely disappears.

In addition to the study of diabetics, a number of other projects have received consideration at the Nutrition Laboratory. Among these are the study in conjunction with Dr. F. B. Talbot of the metabolism of normal and atrophic infants and of infants in the first hours of post-natal life. The importance of knowing the energy requirements and the character of the combustion in the body of the new-born infant has justified an extended research on this subject in which we have studied over 100 infants within the first few hours after birth. The new-born babies were taken from the hospital immediately after birth, placed in the respiration chamber and there studied for several hours, very careful records of the carbon dioxide produced and the oxygen consumed being made. The observations on atrophic hospital infants have supplied values of particular significance in interpreting a number of so-called "physiological laws." Indeed, one of the best methods of studying physiology is to study abnormal physiology.

In connection with the respiration experiments on infants a knowledge of the exact degree of repose of the subject is of importance. I have already shown the enormous influence of severe muscular activity upon the metabolism of man, and it is evident that if, in securing normal data regarding infants, to be subsequently used for comparison with pathological cases, we do not take cognizance of the influence of even minor muscular activity, we are liable to great error. Thus, it would be wholly irrational to compare the metabolism of a normal, healthy infant, but moving and restless, with that of a weak, emaciated infant lying perfectly quiet. Nor is it sufficient to supplement our measurements of the respiratory exchange by records of ocular observations of the activity, for experience quickly showed us that these were wholly inadequate. A method has therefore been devised for automatically recording the muscular activity. The crib in which the baby is placed rests at one end on two frictionless steel points. The other end is supported by a spiral spring having a rubber tube about it. As the infant moves, the air inside of the rubber tube expands or contracts and by means of the air transmission any changes in this tension may be recorded with a delicate tambour and writing point. This adjustment may be so

delicate that even the slight change in the center of gravity of the infant due to respiration, muscular tremors, or movements of the hand or fingers are immediately recorded. These graphic records are now an absolute essential of all metabolism experiments in our laboratory, and unless the records of activity are approximately alike, no use is made of the experimental periods for comparison purposes. Precisely this same principle applies not only to babies, but to the observations on animals, such as dogs, ducks, geese and guinea pigs. Arrangements are made for securing similar records for men and women lying in the bed calorimeter or on a couch connected with the respiration apparatus.

A large number of observations have been made on normal animals, chiefly dogs, rabbits, and more recently geese. The influence of partial inanition, of temperature environment, of the ingestion of various kinds of foods, and of living in an atmosphere containing a high percentage of oxygen have all been the subject of researches which are more or less nearly complete. It was obviously necessary to develop special apparatus and special technique for these researches and in all instances the observations included a large number of control tests of the apparatus and experiments with control animals.

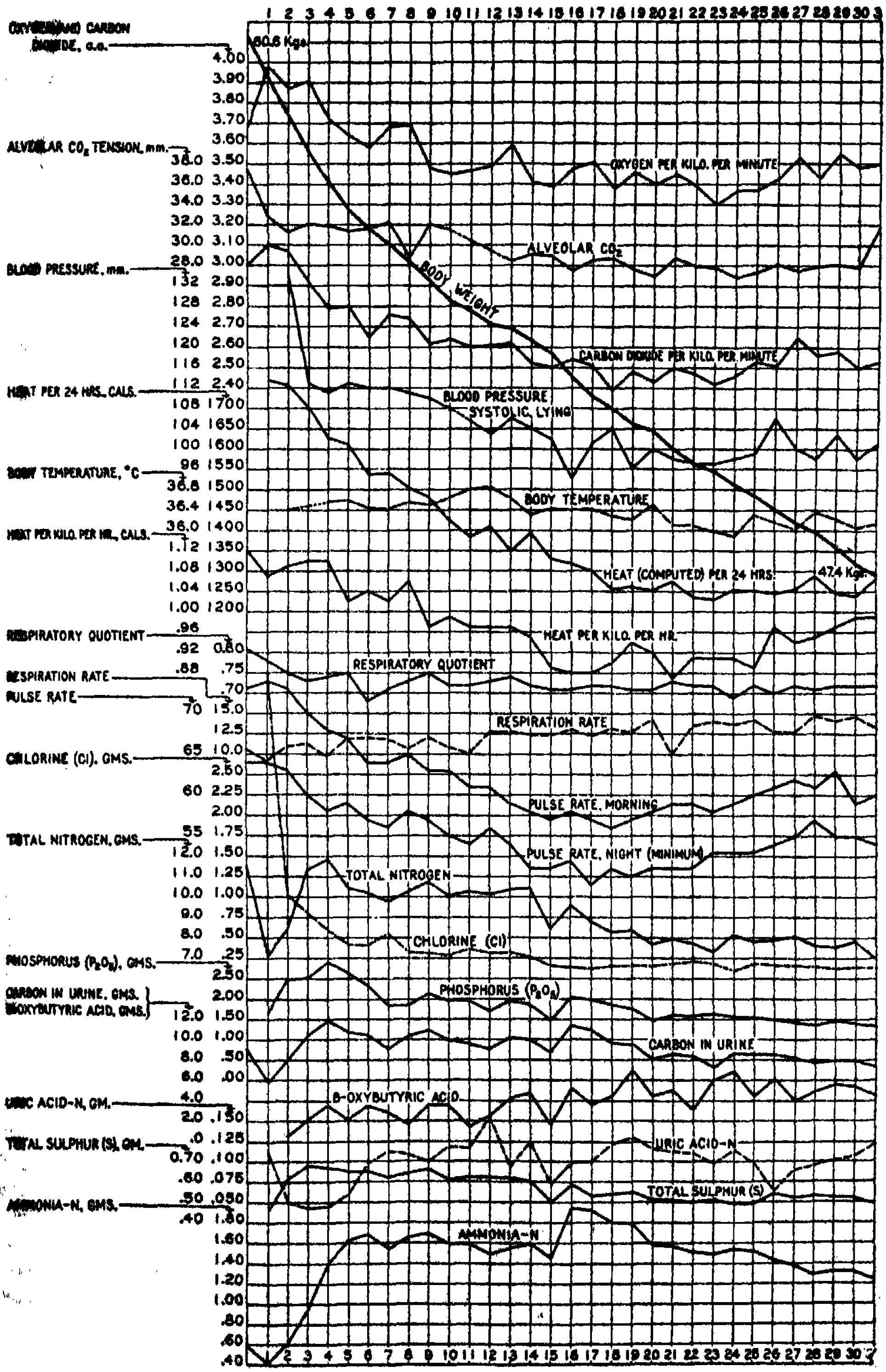
While many, if not indeed the majority of the researches in the Nutrition Laboratory may be considered as of an abstract, scientific nature, one research certainly has far-reaching, practical bearings, namely, the investigation of the influence of alcohol upon the metabolic, neural and muscular processes. The laboratory is at present engaged in an extended program of research on these vexed problems and not only is the influence of alcohol upon the metabolic processes studied with the special equipment of the laboratory, but a special laboratory has been constructed for the study of the influence upon the neural and muscular processes. The equipment of this special laboratory includes the exceedingly ingenious string galvanometer of Einthoven for measurements of the pulse and heart, the faradic stimulus apparatus of Kronecker and of Martin, and particularly the apparatus of Dodge. In the past year the psychological phases of the work have been further extended by Professor Walter R. Miles to include observations on professional typists, with a most careful analysis of the movements and reactions incidental to typewriting. A program for the complete research has been prepared and submitted to a large number of European and American scientists for comment, and the studies will be planned in accordance with this program. Such an elaborate program emphasizes the value of being able to conduct researches continuously for a series of years and thus accumulate definite and authoritative data with regard to problems that have heretofore been studied for the most part in a desultory manner.

Perhaps the most ambitious undertaking of the laboratory thus far has been a recent study of prolonged fasting. Just prior to the establishment of the Carnegie Nutrition Laboratory a special fund was appropriated by the trustees of the Carnegie Institution of Washington for the study of fasting at Wesleyan University, Middletown, Conn. Upon the basis of this investigation plans were made for studying a fasting subject over a long period, but it was not until 1912 that opportunity arose for satisfactorily conducting such a research. The subject fasted for a period of thirty-one days, taking absolutely no food and drinking but 900 c.c. of distilled water per day. The subject was also studied during a short preliminary period and during a three-day realimentation period. During

[NUTRITION LABORATORY OF THE CARNEGIE INSTITUTION OF WASHINGTON, BOSTON, MASSACHUSETTS]

METABOLISM CHART OF A MAN FASTING 31 DAYS

APRIL 14 - MAY 15, 1912



the sojourn of the subject in the laboratory, the entire laboratory staff, with a corps of medical experts, was concentrated upon securing simultaneous observations with this subject. A large number of observations of a purely physiological nature were made, such as body-weight, insensible perspiration, temperature fluctuations, pulse-rate, blood pressure and certain observations on the mechanics of respiration. The gaseous metabolism and the alveolar air were also measured. The subject slept each night throughout the experiment for approximately 10 hours inside of the bed calorimeter. He was under surveillance constantly and it was therefore impossible for him to secure any food. As a result he lived entirely upon body substance, and chemical analyses, which included a study of the gaseous, solid and liquid excreta, gave most important data regarding the breaking down of the material inside the body, and the various components most strenuously attacked as a result of the fasting.

The subject was an ideal one, remaining very quiet. Comparisons of the metabolism and other factors during sleep and during waking were thus perfectly feasible for the first time, and showed the profound influence of sleep upon the metabolism. From the numerous experiments with both the respiration apparatus and the respiration calorimeter and a careful record of the daily activity, the total balance of income and outgo of this man for thirty-one days could be computed with great accuracy. The most important factors of metabolism measured on this subject are indicated on the accompanying chart.

Simultaneous with the physiological and chemical examination, an important psychological study showed that for thirty-one days the subject was able to exist in a fairly normal mental condition. A most rigid and careful clinical examination was made every other day and the subject was under the constant supervision of skilled physicians. All the resources of the laboratory were brought to bear upon this study and the whole project illustrates in the best manner possible the particular advantages of a laboratory of this type and the peculiar obligations of workers in the laboratory to undertake in so far as possible only those researches that can not be satisfactorily studied elsewhere.

Francis G. Benedict

NEANDERTAL MAN IN SPAIN: THE LOWER JAW OF BAÑOLAS

It is not generally realized that the first skeletal remains of what is now known as *Homo neandertalensis,* or Mousterian man, were found in Spain at Gibraltar in 1848. This preceded the discovery in the valley of the Neander by nine years. In many respects the Gibraltar skull is still one of the most important specimens of this type of early man. Although its distinctive characters were early recognized by both Falconer and Busk, the discovery of the man of Neandertal coming at a more opportune time was the first to win and hold the attention of the scientific world: hence for the name of that race we have *Homo neandertalensis* instead of *H. calpicus* (from Calfé, the old name for Gibraltar).

The history of the Gibraltar skull is almost paralleled by that of another discovery in Spain, not near Gibraltar but in the northeasternmost province, Gerona, near the eastern end of the Pyrenean chain of mountains. Some 23 km. north-northwest of Gerona, the capitol of the province of the same name, in the center of a depression lies the lake of Bañolas, now only a remnant of what it once was. Immediately to the east of the southern end of the lake is the town of Bañolas built on travertine beds left by the former greater lake. These rest on early Quaternary [illegible] clays and have been exploited extensively for building purposes. The quarry of Don Lorenzo Roura is near the northern limits of the

town in what is called "Llano de la Formiga." Here in April, 1887, he encountered a human lower jaw embedded in the hard travertine at a depth of from four to five meters. Fortunately Roura left the fragile jaw, almost complete, in its stone matrix and turned the block over to a Bañolas pharmacist, Don Pedro Alsius, who undertook the preparation of the specimen by the careful removal of the matrix from the bone. The relic is still in the private collection of Alsius, or rather of his family, for he died early in 1915. Although he published nothing concerning the specimen, Alsius recognized its archaic character. The first printed notice seems to have been that in "Anuari del Institut d'Estudis Catalans," Barcelona, 1909, by Professor Manuel Cazurro. Another note by Professor E. Harlé appeared in 1912 in the *Boletin del Instituto Geológico de España* (Madrid). Now comes an exhaustive study entitled "La Mandibula Neandertaloide de Bañolas," by Professors E. Hernandez-Pacheco and Hugo Obermaier.[1]

On account of its fragile character no attempt has been made to separate the lower jaw wholly from its matrix. Its inner surfaces are therefore not accessible. The outer surfaces including a full set of sixteen teeth are laid bare. The bone is of the same color as the matrix and highly fossilized. The right side is fairly well preserved. The condyloid process however is entirely gone. The anterior portion of the coronoid process is nearly complete; but its highest point can not be definitely fixed. A small piece is missing from the angle at the junction of the horizontal with the ascending ramus, but its negative is so well preserved by the tufa that the gonion can be determined with accuracy.

The left half of the jaw was broken in seven pieces when discovered. These have been successfully united. But owing to a very early break the whole left half is shoved outward and backward to a slight degree, a defect which can not be remedied. The left ascending ramus is not in so good a condition as the right. While the coronoid and condyloid processes are missing, the transverse diameter of the latter can be measured because of the tufa negative. Nearly the whole of the condyle lies inside the plane of the outer surface of the ascending ramus if extended, as is the case with the lower jaw of La Chapelle-aux-Saints.

The neck of the condyle is short; the coronoid process, low and blunt as seen in the nearly intact right ramus. The ascending branches are relatively low and broad. The body of the lower jaw is also low but robust. The chin is at least rudimentary if not wholly lacking; the angle of symphysis is 85°, placing the man of Bañolas in the same class with that of La Ferrassie. In some Neandertal examples the absence of chin is more pronounced and the angle of symphysis correspondingly greater as seen in the following table from Boule:

Recent man (individual variations) ..	57° to 93°
Lower jaw of La Ferrassie	85°
Lower jaw of *Bañolas*	85°
Lower jaw of La Naulette	94°
Lower jaw G and H of Krapina	99°
Lower jaw of La Chapelle-aux-Saints.	104°
Lower jaw of Mauer	105°
Lower jaw of Malarnaud	105° to 110°
Lower jaw of Spy	106° to 111°
Lower jaw of the Gorilla	105°
Lower jaw of the Chimpanzee	115°
Lower jaw of the Orang	124°

The lower jaw of Bañolas belonged to a male, who had reached the age of about forty years. Morphologically it falls within the Neandertal group, being the second discovery of this type in Spain. Unfortunately it was associated neither with other skeletal remains nor with artifacts. The travertine and the lower jaw itself are undoubtedly Pleistocene. If not so archaic as the Gibraltar skull, it might well be as old as the remains from La Ferrassie, which were associated with a typical Mousterian industry.

GEORGE GRANT MACCURDY

YALE UNIVERSITY,
NEW HAVEN, CONN.

1 "Comisión de Investigaciones Paleontologicas y Prehistoricas," memoria numero 6, Madrid (Hipodromo), 1915.

CALIFORNIA MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA

The business sessions of the summer meeting of the society are to be held as planned at the University of California and Leland Stanford Junior University, August 3–5, 1915, in affiliation with the American Association for the Advancement of Science.

The sessions of Tuesday and Wednesday, August 3 and 4, will be held at the University of California and that of Thursday, August 5, will be held at Stanford University. Morning sessions at Berkeley will begin at 10 o'clock; Stanford University, at 10:30 o'clock. Afternoon sessions open at 2 o'clock. Train leaves San Francisco 9 A.M., arriving Palo Alto at 9:54.

The society's subscription dinner will be held at the Engineers Club, San Francisco, at 7 o'clock on the evening of Wednesday, August 4. The price is $1.50 per plate. Early notice of intention to participate in the dinner should be sent to the secretary of the Cordilleran Section, Mr. J. A. Taff, 781 Flood Building, San Francisco.

Excursions, August 6, to Point Reyes Station, Marin County, for an examination of the San Andreas earthquake rift and to Mussel Rock, San Mateo County, for an examination of Pliocene strata, the type section of Merced formation and the post-Tertiary deformation of the coast.

August 7 to Santa Cruz for an examination of uplifted marine terraces.

August 9 and 10 (with the Paleontological Society) to Mount Diablo for an examination of the Mount Diablo overthrust and the succession of Tertiary strata and to Walnut Creek.

August 11 and following days, to Yosemite with F. E. Matthes and E. C. Calkins.

The Shattuck Hotel at Berkeley has been selected for the hotel headquarters where rooms may be had from $1.50 up. Reservations should be made in advance. For a complete list of hotels with rates see SCIENCE, Vol. XLI., No. 1068, June 18, 1915, page 893.

Information regarding railroad routes and rates from the east may be gathered from SCIENCE, Vol. XLI., No. 1069, June 25, 1915, page 935.

The principal features of the program are the following symposia:

On Erosion and Deposition in Arid Climates, led by H. E. Gregory.

On Diastrophism of the Pacific Coast, led by Andrew C. Lawson.

On Petrological Problems of the Pacific Area, led by R. A. Daly.

On Seismology of the Pacific Coast Region.

On Ore Deposits, led by C. F. Tolman.

The first four will be held at the University of California and the last at Leland Stanford Junior University. The afternoon session of Wednesday will be devoted to seismology.

The following titles have been submitted thus far, others may be included in the daily program.

John D. Clark (introduced by C. F. Tolman, Jr.), "The Rôle of Colloidal Migration in Ore Deposits" (15 minutes).

William Herbert Hobbs, "Origin of the Basins within the Hamada of the Libyan Desert" (20 minutes).

William Herbert Hobbs, "Limited Effective Vertical Range of the Desert Sand-blast, Based upon Observations made in the Libyan Desert and in the Anglo-Egyptian Sudan" (20 minutes).

J. C. Jones (introduced by J. C. Merriam) "Origin of the Tufas of Lake Lahontan" (20 minutes).

Andrew C. Lawson, "The Profiles of the Desert" (30 minutes).

George D. Louderback, "Structural Features of the Tsin Ling Shan" (60 minutes).

J. C. Ray (introduced by C. F. Tolman, Jr.), "Examples of Successive Replacement of Earlier Sulphide Minerals by later Sulphides at Butte, Montana" (lantern slides, 15 minutes).

A. F. Rogers (introduced by C. F. Tolman, Jr.), "Sericite, a Low Temperature Hydrothermal Mineral" (lantern slides, 20 minutes).

C. F. Tolman, Jr., "Bajadas of the Santa Catalina Mountains, Arizona" (20 minutes).

C. F. Tolman, Jr., "Chemical Interpretation of Certain Data Furnished by the Microscopic Investigation of Ores" (lantern slides, 30 minutes).

Harry O. Wood (introduced by A. C. Lawson), "On a Possible Causal Mechanism for Heave Fault-slipping in the California Coast Range Region" (30 minutes).

S. W. Young (introduced by C. F. Tolman, Jr.), "Certain Chemical Factors Governing Secondary Enrichment" (45 minutes).

Inasmuch as the secretary of the society is now leaving on an expedition which will keep him out of the country for about three months, requests for further information regarding the summer meeting of the society should be sent to Mr. Taff at the address given above. Additional titles of papers to be presented at the meeting should likewise be sent to him direct.

The summer meeting of the Paleontological Society will be held at Berkeley and Stanford University in affiliation with the Geological Society on the same dates. Details of the program and excursions may be learned from Dr. R. S. Bassler, U. S. National Museum, Washington, D. C., or Dr. J. C. Merriam, Leland Stanford Junior University, Stanford University, California.

The meeting of Section E of the American Association for the Advancement of Science will be merged in that of the Geological Society of America. Members of the section are cordially invited to attend the sessions and take part in the open discussions.

EDMUND OTIS HOVEY,
Secretary

AMERICAN MUSEUM OF NATURAL HISTORY,
NEW YORK

SCIENTIFIC NOTES AND NEWS

DR. RICHARD H. CREEL, of the United States Public Health Service, has, after first declining on account of his health, now accepted the appointment as health commissioner of the city of Boston.

THE American Ambassador to France presented on June 24 the American Geographical Society's gold medal to M. Vidal de Lablache, the distinguished French geographer.

THE British Institution of Mining Engineers has awarded its medal this year to Dr. J. S. Haldane, F.R.S., in recognition of his work on the causes of death in colliery explosions and other subjects connected with mines.

PROFESSOR MILTON J. ROSENAU, of the Harvard Medical School, has been elected president of the American Society of Tropical Medicine.

AT the annual meeting of the American Surgical Association held in Rochester, Minn., last month, the following officers were elected: President, Dr. Robert G. Le Conte, Philadelphia; vice-presidents, Drs. Charles L. Gibson, New York City, and Archibald MacLaren, St. Paul; secretary, Dr. John H. Gibbon, Philadelphia; recorder, Dr. John F. Binnie, Kansas City, Mo.; and treasurer, Dr. Charles H. Peck, New York City. The 1916 meeting will be held in Washington.

DR. C. JUDSON HERRICK, professor of neurology in the University of Chicago, has been elected president of the honorary scientific society, Sigma Xi, at that institution. Director Edwin Brant Frost, of the Yerkes Observatory, has been elected vice-president.

MR. J. B. TYRRELL, of Toronto, was elected president of the Geological Section of the Royal Society of Canada at its recent annual meeting.

THE Alabama Polytechnic Institute has conferred the degree of doctor of science upon Altus Lacy Quaintance, in charge of deciduous fruit insect investigations in the U. S. Bureau of Entomology. Dr. Quaintance was at one time a student at this institution taking his master's degree there. This is the first doctorate of science conferred by the institution.

THE honorary degree of doctor of laws has been conferred by the University of Cambridge on Professor G. B. Mathews, F.R.S., formerly fellow of St. John's College, Cambridge, and on Dr. G. S. Middleton, president of the Association of Physicians of Great Britain and Ireland.

AT Cambridge University the Wiltshire prize in geology and mineralogy has been awarded to Mr. D. B. Briggs, of Jesus College. The Frank Smart prize in botany has been awarded to Mr. E. J. Maskell, Emmanuel College, and that in zoology to Mr. L. T. Hogben, of Trinity College.

PROFESSOR E. B. POULTON has been elected president of the Linnean Society.

Dr. George S. Graham has been appointed second assistant pathologist and Dr. Edgar M. Medler research assistant in pathology, at the Boston City Hospital.

Dr. Irving Perrine, professor of geology and paleontology at the University of Oklahoma, has resigned to become head geologist to the Pierce Oil Corporation, of St. Louis, Mo. With him goes Mr. L. E. Trout, at present chief geologist of the Oklahoma State Geological Survey. They will make their headquarters at Oklahoma City, Okla.

Curator William C. Mills, of the Ohio State Archeological Museum, will leave for Scioto County in two weeks, where he with two assistants, H. C. Shetrone, of the museum, and William Holdermann, of Columbia University, will superintend explorations in the mounds of that vicinity. This trip is taken by members of the Ohio State Historical and Archeological Society each year. The party which includes, besides a photographer, a surveyor and a working force, will live in tents during the summer. Data and relics will be collected and afterwards tabulated and recorded by Dr. Mills. Bound copies will be made of these records and placed in the museum.

Dr. Richard C. Cabot has been appointed medical adviser to Radcliffe College.

Sir Nathaniel Barnaby, the British naval engineer, died on June 15, at eighty-six years of age.

UNIVERSITY AND EDUCATIONAL NEWS

In honor of Dr. Wheeler, since 1899 president of the University of California, the regents have voted that the new classroom building to be begun in July, 1915, shall be named Benjamin Ide Wheeler Hall. This white granite building is being erected at a cost of $800,000 from proceeds of the bond issue of $1,800,000 voted in November, 1914. Plans are being prepared also for an additional agricultural building to cost $350,000; for the first unit of a new group of chemistry buildings, this structure to cost $250,000; and for the completion at a cost of $400,000 of the university library.

Arrangements for an exchange of professors between the University of Washington and the University of the Philippines have progressed to the stage where it is probable that Dr. Horace G. Byers, professor of chemistry in the University of Washington, will spend the next year in Manila. In the event of his going, Professor Horace G. Deming, a graduate of the University of Washington, head of the department of chemistry in the University of the Philippines, will go to the University of Washington for the year.

The trustees of Cornell University have elected Alexander M. Gray to be professor of electrical engineering and head of the department of electrical engineering in Sibley College. Professor Gray will begin his work at Cornell in the fall. He has been for several years a member of the faculty of McGill University. The head professorship of electrical engineering in Sibley College was resigned by Professor H. H. Norris two years ago and Professor Vladimir Karapetoff has been acting head of the department.

At the Carnegie Institute of Technology, James Burt Miner, of the University of Minnesota, has been appointed assistant professor of psychology. Louis L. Thurstone, graduate student at the University of Chicago, and Margaret L. Free, of Bryn Mawr, have been appointed assistants in the bureau of mental tests. Jonathan L. Zerbe and Katharine Murdoch remain as instructors in educational psychology. Among the aims of the department is the study of the psychology of industrial processes and of the teaching of those processes.

Dr. W. C. Allee, who had charge of the department of zoology at the University of Oklahoma this year, during the temporary absence of Dr. H. H. Lane, has been appointed head of the department of zoology of Lake Forrest College.

Dr. F. E. Chidester, assistant professor of biology and in charge of the courses in zoology at Rutgers College, has recently been promoted to the headship of a new department of zoology, with the rank of associate professor.

Dr. Geo. I. Adams, who has been professor of geology and mining at the Pei Yang University at Tientsin, China, has been appointed to the faculty of the Government University at Peking.

Mr. C. T. R. Wilson, F.R.S., lecturer in experimental physics at the University of Cambridge, has been elected to a fellowship in Sidney Sussex College for a period of five years.

The board of Trinity College, Dublin, has appointed Miss E. M. Maxwell, of the Royal Victoria Eye and Ear Hospital, Dublin, to the Montgomery lectureship in ophthalmology.

DISCUSSION AND CORRESPONDENCE

APPLICATION OF PETROGRAPHIC METHODS TO ANALYTICAL CHEMISTRY

When it is considered that minerals are fundamentally more or less definite chemical compounds and that optical mineralogy has attained a high stage of development and importance, it is a matter of considerable surprise that the application of petrographic methods to general chemistry has been attempted in so relatively few instances and that at present, speaking generally, crystal optics is a subject almost unheard of among the great majority of chemists. Chemical literature is filled with such vague crystal descriptions as "needles," "tablets," etc., which it is hardly necessary to say are almost worthless—absolutely so when taken out of connection with the reactions of the compounds. Crystallographic measurements are not always possible, are tedious, and lack general applicability. Microchemical reactions usually resolve themselves into simple observation of the appearances of the crystals formed, a procedure open to the objection that in many cases very diverse substances crystallize rather similarly. Petrographic methods are open to none of these objections. In a very large number of substances the optical data is definitive. The methods are of general applicability to crystalline material regardless of the existence or non-existence of crystal faces, and are rapid and comparatively simple.

It is well known that the rock-forming minerals are now usually determined by microscopic examination and that it is even possible to calculate approximately the chemical composition of a rock from the data thus obtained. In some rather rare instances these same methods have been extended to chemical compounds other than minerals. In 1898 J. L. C. Schroeder van der Kolk[1] published an acount of petrographic methods and applied them to certain artificial salts. Otto Rosenheim[2] by a determination of the optical characters, positive or negative, of phrenosin and kerasin, obtained from the brain, succeeded in differentiating these two substances. This test was confirmed in this laboratory on the same materials obtained from molds. Fry[3] has applied petrographic methods to the determination of the various salts ordinarily occurring in commercial fertilizers, and to the determination of mixed solids obtained in certain phase-rule work,[4] all cases where chemical analysis could not give the desired results. In a very recent address before the Chemical Society of Washington Dr. F. E. Wright called attention to the utility of petrographic methods in chemical analysis, and during this address and the succeeding discussion several specific applications were pointed out, notably that of the differentiation of the sugars. The published reports of Dr. Wright and coworkers afford numerous instances of the valuable application of petrographic methods to many substances, especially in the examination of products obtained in various melts. This work can not be too highly commended. Chamot[5] has emphasized the usefulness of the methods.

Recently the literature has been searched and practically complete optical data has been found for over 375 chemical individuals ranging from simple elements to the more complex inorganic and organic compounds. In addition there is an immense number of compounds of which some of the data is known. This makes it quite possible to definitely identify quite a

[1] "Kurze Anleitung zur Mikroskopischen Krystallbestimmung," Wiesbaden.

[2] *Biochem. Jour.*, 8, 110, 1914.

[3] U. S. Dept. of Agric., Bul. 97, 1914.

[4] Parker, *Jour. Phys. Chem.*, 18, 653–61, 1914.

[5] "Elementary Chemical Microscopy."

number of chemical individuals and to differentiate a vastly larger number. For simple differentiation, however, it should be understood that it is not necessary that any data be known since sufficient may usually be obtained in five minutes or less.

It is obvious that by the use of petrographic methods in chemical work an immense amount of time can be saved, a saving that overwhelmingly counterbalances the initial cost of equipment and the rather unimportant trouble of learning the methods. With numerous substances the necessity for tedious qualitative analysis can be obviated or at least greatly limited. Reagents or precipitates, where extremely accurate results are not sought, may be examined for purity with scarcely more than a glance. This is of great value in various phases of drug examination or general inspection work. In this laboratory the petrographic microscope has supplanted a large amount of routine chemical analysis with a consequent saving of both time and reagents.

This paper is written with the purpose of calling to the attention of chemists the fact that, while the petrographic microscope can never entirely supplant chemical analysis, it may be and actually is an aid which can not fail to be of very great service both to the research and to the commercial worker.

William H. Fry

Bureau of Soils,
U. S. Department of Agriculture,
Washington, D. C.

TO THE AMERICAN PHYSICAL SOCIETY

In his announcement of June 25th to the members of the American Physical Society, Professor Cole expresses the fear that there will not be room on the program of the San Francisco meeting of August 6 for many papers from eastern members. Evidently Professor Cole has overestimated the numbers or the scientific activity of the members of the Physical Society on the Pacific Coast.

It is the belief of the coast committee on program that there will be ample time for the reading of all papers that our eastern members are willing to present, and accordingly this committee especially invites papers from the eastern members at this session.

Fernando Sanford,
E. P. Lewis,
For the Committee

A CORRECTION

May I be allowed to call attention to a printer's error in my article entitled "Some Reasons for Saving the Genus," which was published in Science for June 18, 1915? The concluding sentence (p. 902) was rendered entirely ineffective by the omission of a line. The sentence should read: "In this conflict the 'general biologist' should, I think, lend his support to that faction which shows the higher regard for the interests of the scientific public."

F. B. Sumner

A CHICKEN WITH FOUR LEGS

On December 15, 1914, a chicken was hatched out of one of our settings which had four legs. It lived from one evening to the next noon when it was stepped upon by the mother-hen and killed. It seemed to be normal in every other respect, eating and walking about like the others, of the usual markings and full size but not unusually large.

The two extra legs were at either side of the extreme rear of the body, appeared to be complete in all the essentials, having the three main toes and the small toe together with toenails. These extra legs were about two thirds the size of the principal ones, were a lighter yellow in color and had the toes facing the rear, the opposite to the ordinary ones.

In walking, the chicken curled up the extra legs behind it, using only the principal ones.

It was of the Plymouth Rock breed and nothing unusual was noticeable about any of the eggs of the setting. There did not seem to be anything unusual in the fertility of the eggs—hatchings running from two to eleven chickens. Six eggs of the setting in question hatched and all the remainder appear entirely normal.

This specimen was sent to the Museum of the Escuela de Agricultra here.

C. D. Perrine

Córdoba, December 22, 1914

SCIENTIFIC BOOKS

Vorlesungen über allgemeine Histologie gehalten an der Hochschule für Frauen in St. Petersburg. VON ALEXANDER GURWITSCH. Jena, Gustav Fischer, 1913. Pp. vi + 345. 204 figs.

Professor Gurwitsch has taken seriously his task of instructing the college women of Petrograd. He has prepared for them a course so philosophical that if adopted for American young men, the audience would be restive, if not more disrespectful. But he appreciates that he is not dispensing milk for babes, and quotes Helmholtz that the academic teacher should always be mindful of this—that among his hearers there are perhaps "die besten Köpfe" of the next generation, and they are to be reckoned with. Accordingly he presupposes an "elementary zoological, anatomical and botanical knowledge" on the part of his students, and correctly infers that his work "perhaps makes greater demands upon the attention of the reader than many another compendium of histology." For this the reader is amply rewarded.

The first of the twenty-two lectures deals with "the position of histology in the system of the biological sciences." In this abstract consideration, histology is shown to be far removed from a naïve, automatically-recording science, limited only by optical and technical difficulties. Its real difficulties are those of subjective interpretation, and the author ranks it high among the various attempts to secure a better understanding of vital phenomena. But he emphasizes the fact that the study of structure is only one method of approach among many which are available, and "we do not know how far toward the goal it can lead us."

Each subject discussed in the lectures is introduced with the formulation of a biological problem. Thus the second lecture—on "the fundamental conceptions of microscopic morphology"—begins with the statement that the first and most urgent problem is the endless *multiplicity of forms* which organisms present. Can all organisms be regarded as various arrangements of one or a few sorts of structural elements? It is then shown that the Protista, from the simplest amebæ and bacteria to the highly organized infusoria, appear irreducible. They show an essential agreement only in the "heterogeneity of their architecture." But such forms as the hydroid polyps, the vegetative buds of *Equisetum* and embryos of the higher animals, are composed of elements, or cells, which show many more interrelationships and analogies among themselves than are presented by the organisms *in toto*. To this extent the cell theory is justified and significant. In the adults of the higher animals, however, the consideration of striated muscle fibers and of various supporting tissues leads the author to state that the cell theory is here "simply inadequate," and he finds that "the ground substance, the cell, the fiber (ducts in plants), etc., must be accepted as coordinate descriptive material in our histological inventory." But he regards granules as having no more general characters than their configuration, and every granule theory is declared illusory.

The third lecture is entitled the "substratum of development," and approaches the problem of the origin of new organisms. After noting that the earliest beginning of the future organism which can be recognized and individualized as such, has its own antecedent in the maternal organism, not recognizable with the methods of to-day but which may be with those of to-morrow, Dr. Gurwitsch proceeds to consider the ovum, and thus the nature of protoplasm in general. In abbreviated form, he writes:

> The investigation of protoplasmic structure is among the pet problems of histology. If only seldom expressed, most of such studies have been inspired by the wish and hope of finding something in the structure of protoplasm which would explain its "properties." But this hope gradually paled as the investigator became lost in the labyrinth of microscopic pictures. There was a lack of sufficient appreciation of the part which induction plays in apparently so simple a procedure as describing what is seen. Many times we imagine that we accomplish this in a purely objective way, when in

fact we offer an interpretation. Since the pictures admit of different interpretations they must be examined in the light of the physical properties of protoplasm. To have perceived and applied this postulate is the unperishable contribution of Bütschli.

Accordingly nucleus and protoplasm are thoroughly examined in their physical and chemical relations, and the manifold structural forms assumed under the microscope are partially explained by considering protoplasm a very soft gel, near the critical condition. "Under various abnormal or perhaps physiological conditions it may wholly or in part become a sol."

Two lectures are devoted to cell division, and like all other parts of the book, they are illustrated with large, clear, beautifully executed figures, derived from many sources. Collectively they suggest faultless technique and the clearest of objectives. The account of mitosis imparts the fascination which this process still holds upon the lecturer through its inherent mystery, and the subject is left with the following characteristic conclusion:

> Why the number of chromosomes and their size are so very different in closely related species or races; why specially in the seminal cells of one representative of the cyclostomes (*Myxine*) peculiarly formed rod-shaped centrosomes appear; why the centrosomes of a particular annelid (*Rhynchelmis*) attain enormous, macroscopically visible dimensions, etc.; these all are problems the rational explanation of which can not be hoped for in the years within sight.

The course continues with a consideration of the following themes: Growth; the substratum of inheritance; shape and structure; the histology of metabolism; change of form and motion; the nervous system; and finally, the possibility of establishing histological laws. Each of these subjects is treated in one or more lectures, with freshness and originality. The two lectures on "shape and structure" state that the adult is characterized by relatively stabile weight and fixed shape, and this condition is attributed to "the high degree of elasticity in the adult organism as contrasted with the plasticity of embryonic stages." The structures accounting for these characteristics of the adult are then considered—epithelium and its modifications in the first lecture, with the conclusion that "in maintaining the typical shape of the organism, epithelial tissue as such plays a subordinate rôle"; and connective tissue, with cartilage and bone, in the second lecture.

As a whole the lectures are to be highly commended. Their unsolved riddles may perhaps suggest to others, as to the reviewer, the difficulties of Carlyle's Teufelsdröckh, but much is in store for the English readers who "accompany him through all his speculations." Of inconsistencies we have noted only one, and can not decide which of the following propositions is correct:

> Histological investigation is seldom or only exceptionally able to take the lead over other methods of investigation as a pioneer in unknown lands (p. 11).

> Histology belongs essentially to the sciences of discovery, *so that histological discoveries have* often, or very generally, the same exploratory character as the voyages of the early mariners (p. 4).

Frederic T. Lewis

Flies in Relation to Disease—Bloodsucking Flies. By Edward Hindle, B.A., Ph.D. Cambridge University Press, 1914.

This volume is one of the Cambridge Public Health series and complements the recent work on flies in relation to disease by Dr. G. S. Graham-Smith. It was written in collaboration with the distinguished investigator, Major S. R. Christophers, who, for reasons stated in the preface, did not consent to appear as joint author. In its preparation the author was also guided by Professor G. F. H. Nuttall. It is therefore to be supposed that it measures up to the standard set by the noted Quick Professor of Protozoology in Cambridge University. The reader will find as he proceeds through the work that this is the case.

Dr. Hindle's volume deals with the most important field in medical entomology at the present time as its scope includes the treatment of species transmitting such important maladies as malaria, yellow fever, sleeping sickness and others. In this field much activity

has been displayed in recent years. Most of the European nations which have possessions in Africa have sent scientific expeditions to that continent to study the insect-borne diseases. In the case of England, the Royal Society, the Imperial Bureau of Entomology, and the great schools of tropical medicine have sent such expeditions. As there has been an urgent demand from administrative officers and others for early information on the subject of African insect-borne diseases, many of the commissions and investigators have published preliminary or progress reports from time to time. The undertaking of the author of this book was to summarize and correlate as far as possible the findings of the different investigators which in many cases have not been harmonious. Dr. Hindle himself has conducted investigations in various parts of Africa and adds his own views to those of other investigators on points which are by no means settled.

The general plan of the work is to combine the necessary entomological and medical features of the problem so that the accounts of the different diseases will be complete. In the treatment of diseases borne by mosquitoes, for instance, a full discussion of the classification of the mosquitoes is given. This is followed by a series of chapters on the diseases such as malaria and yellow fever which these insects transmit. The completeness of the work may be judged from the table of the two hundred and forty-one species of anopheles, their classification and generic synonymy, and notes on their habitat and connection with malaria. Even with such complete special discussions the work is well balanced, but its chief characteristic is its inclusiveness and the good judgment the author has displayed in the exclusion of immaterial details.

Dr. Hindle lost his life in military operations in Africa, where he was continuing his investigations of tropical diseases, soon after the outbreak of the war. He was a young man and would undoubtedly have made further valuable contributions to the study of insect-borne diseases. But the present book may be considered a monument that will mark his place, which was an important one in the study of tropical diseases at a time when such work as his was much needed.

W. D. HUNTER

SPECIAL ARTICLES

THE DIFFUSION OF GASES AT LOW PRESSURES MADE VISIBLE BY COLOR EFFECTS

AN interesting and instructive experiment for the lecture table is to connect a discharge tube *AC*, which is about one meter or more in length and which has the exhaust nipple at one end, to a pump that will give a Geissler vacuum—an oil Geryk pump will answer very well. Between the pump connection *M* and the valve *O* that closes the tube there should be fused a side branch *N* also having a valve. Connect *N* by a rubber tube to some source of gas other than air, *e. g.*, ordinary illuminating gas. The connection at *M* should be made direct to the pump. Connect *A* and *C* to the terminals of an induction coil that will give a spark in air five or more centimeters long.

To operate, close the valve in the branch *N*, open *O* and evacuate the discharge tube to the point where on sparking the characteristic striæ show distinctly. It is immaterial whether *A* or *C* is the cathode, or whether the discharge is unidirectional. Now close the valve *O*, and, with the pump still running, open *N* partly, allowing illuminating gas to be drawn by the pump through the branch *OM*, thus displacing the air by the gas. By closing *N*, pumping and later admitting more gas, every trace of air may be washed out of

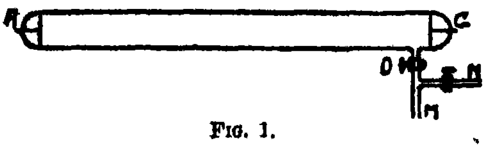


FIG. 1.

the tube leading up to *O*. Now with *N* closed allow the pump to run for a few seconds until it is judged that the pressure in the connecting tube *MO* is about that in the discharge tube *AC*.

At this stage everything is in readiness for the experiment, namely, the diffusion of gases at low pressures made visible by the color effect. The well-known characteristic color of the discharge in the case of residual air, con-

taining possibly some water vapor, is orange red. To now introduce the illuminating gas open the valve O for a moment, then close it. The end C of the discharge tube is instantly filled with a beautiful greenish-white color characteristic of illuminating gas. This color will diffuse slowly towards A, each color paling out, and after three or four minutes the discharge throughout the tube will assume a uniform grayish hue. The rate of diffusion is surprisingly slow and of course depends upon a number of factors, *e. g.*, the gas pressure in the tube, the pressure of the gas that is admitted, the ionization within the tube due to the discharge passing through the tube, the amount of moisture present, etc.

If now the gas connection at N be removed and this stem opened to the air the pump and connections may be freed of gas and the inverse experiment performed; namely, that of introducing a small quantity of air. The resulting orange red color and its diffusion through the grayish hue of the illuminating gas is even more striking than the first.

The success of the experiment depends largely upon the skill of the operator in properly proportioning the quantity of gas to be introduced. It is a very simple experiment to perform.

CHAS. T. KNIPP

LABORATORY OF PHYSICS,
UNIVERSITY OF ILLINOIS,
June 2, 1915

THE NEW ORLEANS MEETING OF THE AMERICAN CHEMICAL SOCIETY. III

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

G. A. Hulett, *chairman*
R. C. Wells, *secretary*

E. R. WEAVER: *A Colorimetric Determination of Acetylene.*

A new colorimetric method for the determination of very small amounts of acetylene in gas mixtures depends upon the formation of a red colloidal solution of cuprous chloride containing gelatine and alcohol. Comparison is made with a solution of a red dye or a piece of ruby glass. In the gravimetric determination of acetylene it has been found necessary to exclude air during the filtration and washing of the precipitate.

GEORGE W. MOREY: *The Ternary System K_2O-SiO_2H_2O from 300°–700°.* (Lantern.)

E. C. FRANKLIN: *Rubidium Ammonosodate and Ammonopotassiate.*

R. S. McBRIDE: *Experiments on the Distillation of Liquid Air in a Magnetic Field.*

Preliminary experiments on distillation of liquid air in a strong magnetic field indicate that there is an improvement in the separation of oxygen and nitrogen due to the influence of the magnetic field.

E. P. SCHOCH and DENTON J. BROWN: *A Systematic, Rapid, Electroanalytical Procedure for the Separation and Determination of Silver, Arsenic, Copper, Bismuth, Antimony, Tin, Lead and Cadmium.*

In our earlier work, published elsewhere, we have shown that copper, tin, lead, bismuth and antimony can be determined accurately by electrodeposition out of acidified chloride electrolytes which contain suitable reducing agents such as hydroxylamine or formalin. We have found since that copper, bismuth and antimony can be deposited simultaneously, and can be separated from tin and lead; that tin and lead can be deposited simultaneously and separated from cadmium; that copper or bismuth can be separated from antimony by dissolving alloys of these metals in nitric acid plus tartaric acid and electrolyzing the solutions with a limited cathode potential; that bismuth phosphate can be precipitated quantitatively out of the same solution; that tin may be separated completely from lead by dissolving an alloy of these two metals in nitric acid plus potassium nitrate; and that silver in silver chloride may be determined by dissolving the latter in ammonia, adding ammonium nitrate and electrolyzing.

These facts are all combined in the following systematic procedure for the rapid electroanalytical determination of all the common metals the potentials of which are more noble than that of cadmium.

(*A*) Dissolve sample in hydrochloric acid or in aqua regia; an insoluble residue—silver chloride—is dissolved in ammonia plus ammonium nitrate, and the silver determined electrolytically.

(*B*) Treat solution *A* with hydroxylamine—mercury, gold and platinum will be precipitated and can be determined by well-known methods.

(*C*) Out of filtrate *B*, remove arsenic by distillation with hydrochloric acid, and determine arsenic iodometrically.

(*D*) Electrolyze *retort residue C*—copper, antimony and bismuth will be deposited with a cathode potential limited to 0.45 volts (against the normal calomel electrode).

(*E*) Dissolve *metal deposit D* in nitric acid plus tartaric acid, and precipitate bismuth as bismuth phosphate.

(F) Electrolyze *filtrate E* with a limited cathode potential—copper alone will be deposited. Antimony is obtained *by difference*.

(*G*) Electrolyze *residue D* with a cathode potential limited to 0.7 volt against the normal calomel electrode: tin and lead will be deposited. Treat the deposit with nitric acid plus potassium nitrate: the solution contains all the lead, and this metal may be deposited as lead peroxide, or the residue of tin oxide may be dissolved in hydrochloric acid plus hydroxylamine and the tin determined by electrolysis.

(*H*) Electrolyze *residue G* to obtain cadmium or other metals.

P. SCHOCH and W. A. FELSING: *The Influence of the Potassium Ion upon the Potential of the Ferrocyanide-ferricyanide Electrode.*

The potential of the ferrocyanide-ferricyanide electrode is made more noble by the addition of potassium salts to the electrolyte, but the amount of this change in potential is much greater than the amount calculated from the change in the ratio of ferrocyanide to ferricyanide ions when the concentrations of the latter are calculated from the conductivity ratio and with the aid of the rule of mixtures as set forth by Sherrill. It was suggested by Lewis that this extra effect may be due to the potassium ion taking part in the pole reaction. Thus, with the undissociated salts, the reaction would be: $K_3Fe(CN)_6$ plus K-ion plus one electron gives $K_4Fe(CN)_6$—and it has been shown recently by Mueller that with concentrations of potassium ion ranging from 0.2 normal to 0.8 normal the amount of change in potential corresponds to the amount of change in the potassium ion if the concentration relations of the other substances remains constant. Since the latter is not likely to be true, and since the potassium ion shows the same influence even in the most dilute solutions tried, the authors sought to ascertain whether or no the concentration influence of the potassium ion is constant with a particular power of its concentration. This was found to be the case with the .75 power of the potassium ion concentration, and if the ferrocyanide and the ferricyanide ion concentrations are calculated from the conductivity ratio and the rule of mixtures. The various mixtures tried present a range of total potassium ion concentration from 7.8 millimol to 395 millimol *per liter*. In some mixtures the potassium ion was derived wholly from the iron cyanides, in others, almost wholly from potassium chloride, and in others still, partly from both sources. The different potentials thus reduced to unit concentrations present a maximum range of 8 millivolts with this large variation of concentrations, and hence the result may be considered to be constant. Furthermore, it is likely that on repetition measurements will be obtained which will show considerably less variation.

Since the calculations of the above potentials involve the general dilution law of strong electrolytes and the rule of mixtures, it was desirable to test these calculations in some way, hence the conductivities of these mixtures were measured and compared with their calculated values. When allowance is made for the influence of the viscosities of the solutions, then the observed and the calculated conductivities agree to one per cent. and less.

The work is now being repeated with calcium salts in place of potassium salts. Although the immediate result of this work is the establishing of an empiric relation between concentrations and pole potentials, yet it is likely that the results will throw some light on the manner of ionization of salts with polyvalent ions—particularly because other electrodes such as the thallous-thallic, the ferrous-ferric and the mercurous-mercuric, show similar relations.

R. G. VAN NAME and D. U. HILL: *The Rates of Solution of Metals in Ferric Salts and in Chromic Acid.*

The observed rates of solution were lowered by increasing the concentration of free sulphuric acid. In ferric sulphate with 0.5-molar acid the rates differed and were higher the more electropositive the metal. With 10-molar acid the four most electropositive metals tested all gave the same rate. The lowering of the rate with increasing acidity is due to increase in the viscosity, which retards the diffusion. In general all results are in agreement with the diffusion theory of heterogeneous reactions, but the marked dependence upon the nature of the metal, observed at the lower acidity, contradicts Nernst's hypothesis that, where no secondary effects interfere, the rate of the chemical reaction proper (as distinguished from the diffusion process) must always be extremely high.

PAUL M. GIESY and JAMES R. WITHROW: *The Electrolytic Preparation of Solid Alkali Amalgams in Quantity.*

Kerp, by his method, obtained 200 gr. of solid potassium amalgam in 4 to 5 hrs. This method has been modified so as to yield 490 gr. in ½ hr. As previously found, Shepherd's method did not give pure amalgams. Smith and Bennett, by their method, using 3 amp. current, obtained about 180 gr. solid sodium amalgam. By using 20 amp. current, and cooling the cell by an ice-water bath, 680 gr. were obtained in 2½ hrs. It is not necessary to cool the cell in the case of potassium amalgam. After electrolyzing 50 min. with 1,000 gr. mercury and 20 amp. current, 1,015 gr. of solid potassium amalgam were obtained by chilling.

O. L. BARNEBEY: *Permanganate Determination of Iron in the Presence of Fluorides. The Analysis of Silicates and Carbonates for their Ferrous Iron Content.*

In a systematic study of the effect of various reagents toward increasing the accuracy of titrating ferrous iron in the presence of fluorides, boric acid was found to give the best results. Boric acid when added to the ferrous solution preceding titration converts the hydrofluoric acid to metafluoboric acid, HBF_4, which does not interfere with the permanganate reaction. This use of boric acid is applied in the analysis of silicate and carbonate rocks for their ferrous iron content.

O. L. BARNEBEY: *The Permanganate and Iodimetric Titration of Iodide in the Presence of Bromide and Chloride.*

The Pean de St. Gilles permanganate method of titrating iodide to iodate has been modified by adding manganous sulfate with the ferrous sulfate in removing the excess of permanganate. This prevents the liberation of bromine or chlorine at this stage of the analysis as well as later when titrating the excess of ferrous sulfate with the permanganate. After the completion of the permanganate titration the iodate formed may be determined by adding phosphoric acid and potassium iodide and titrating the liberated iodine with thiosulfate.

HAL WALTERS MOSELEY: *The Phenomenon of Passivity in Connection with Ferrous Alloys of Different Composition and Structure.*

The author has shown that samples of iron and steel of very different composition and structure can be made passive with a definite current density when the samples were made the anode in an electrolytic cell. The nature and concentration of the electrolyte are also factors influencing the establishment of the passive state. The current density required is not related in any simple way to the composition or structure of the samples.

The results confirm the view that the phenomenon is perfectly general for all classes of irons and steels, and show that passivifying agents as inhibitors of corrosion have a very wide applicability.

WILLIAM C. MOORE: *The Thermo-electric Properties of Carbon.*

Preliminary experiments with various combinations of arc carbons as thermo couples showed that each particular combination had individual thermoelectric characteristics.

More elaborate measurements were then made with various carbon copper couples. The burning of such couples at high temperatures was so serious that the simple carbon copper couple was modified by enclosing the arc carbon rod within a copper tube, the combination serving as a couple, the tube being partially exhausted by a water pump.

With several of the carbon-carbon couples and some of the carbon-copper couples, a point or a region of maximum electromotive force was found. With one carbon-copper couple this region exceeded from 741° C. to 816° C.; with another carbon-copper couple, this region exceeded from 514° C. to 565° C. These carbons were of different composition and had different manufacturing histories. The temperature coefficient of the electromotive force of these couples was very irregular before reaching the region of maximum electromotive force; after passing through this region this coefficient became more regular, and the slope of the $de/dT - T$ curve changed. The carbon was negative at the cold end, but in one case became positive at a high temperature. The carbon used in a different carbon copper couple was positive throughout the experiment, an E.M.F. of 2.18 millivolts being reached when the furnace temperature was 878° C. In this case the electromotive force did not pass through a maximum.

The electromotive force of the one carbon-carbon couple reached a value of 14.59 millivolts at a furnace temperature of 707° and a cold junction temperature of 55.5°.

In general, this is higher than that reached by

carbon copper couples. The variations shown by any one couple in general are reproducible. The results show that the thermo-electric properties of carbon depend on the initial composition and the manufacturing history of the carbon.

It is possible that the change in direction of the temperature coefficient-temperature curve indicates that some of the carbon material undergoes a transition into some other material. The results here reported seem to show that ordinary carbon is a mixture of several substances—in all probability several varieties of carbon with various hydrocarbon bodies of high molecular weight, since Moissan[2] has shown that all forms of amorphous carbon contain hydrogen.

D. A. MacInnes and Karr Parker: *Potassium Chloride Concentration Cells.*

J. P. Montgomery: *The Precipitation of Lead Chloride in Qualitative Analysis.*

Stewart J. Lloyd: *Radium Content of Water from the Gulf of Mexico.*

Previous Results.—One liter of sea water contains in grams of radium:

Jolly	17.0×10^{-12}
Eve	0.3×10^{-12}
Eve	0.9×10^{-12}
Satterly	1.0×10^{-12}

Seven and one fourth liters of Gulf water evaporated down and measured gave 1.7×10^{-12}. The amount of radium in the ocean is hence probably about 1,400 tons, which implies a content of uranium of 4,200,000,000 tons.

W. A. Taylor: *Studies in the Measurement of the Electrical Conductivity of Solutions.*

William J. Van Sicklen: *Electrolytic Rectification of Alternating Currents.*

A number of cells were devised varying within wide limits several factors affecting the energy efficiency of rectification. The electrodes used were for the most part iron-aluminium, carbon-aluminium, nickel-aluminium. The affect of the following factors on the energy efficiency of rectification were determined: relative area of and distance between electrodes, E.M.F. of the input circuit, resistance in the output circuit, nature and conductivity and temperature of the electrolyte.

[2] "Electric Furnace," p. 48, 1904 ed.—Lenher's translations.

The alternating current used throughout the determinations was of 60 cycle frequency.

William D. Harkins and Ernest D. Wilson: *The Changes of Mass and Weight Involved in the Formation of Complex Atoms.*

William D. Harkins and Ernest D. Wilson: *The Structure of Complex Atoms.*

William D. Harkins and Ernest D. Wilson: *Nuclear and Valence Electrons.*

William D. Harkins and Ernest D. Wilson: *A Periodic Table which Plots the Atomic Weights of the Ordinary and the Isotopic Elements.*

Ernest D. Wilson and William D. Harkins: *A Connection between Planck's Quantum Hypothesis, the Magneton, and the Balmer Series Formula.*

Lloyd C. Daniels: *Cuprous Salts of Oxygen Acids and a New Method for Preparing Cuprous Salts.*

References are given to the salts of this class that have been described. They are the sulfite, sulfate, ammoniated sulfate, carbon monoxide compound of the sulfate, acid thiosulfate and acetate.

The brown insoluble product of the action of oxalic acid on cuprous sulfite is shown by its clear colorless solution in hydrochloric acid, by its clear solution in ammonia, and by its formation of calcium nitrate and nitric acid, to be a new salt of this class. Analysis shows its composition to be $Cu_4H_2(C_2O_4)_4$. The same method is to be applied to the preparation of other cuprous compounds.

M. A. Rosanoff: *A Relational Process of Fractional Distillation.*

WATER, SEWAGE AND SANITATION SECTION

Earle B. Phelps, *chairman*
H. P. Corson, *secretary*

The following list of officers of the Division of Water, Sewage and Sanitation, were elected for 1915:

Chairman: Edward Bartow.
Vice-chairman: Earle B. Phelps.
Secretary: H. P. Corson.
Executive Committee: Edward Bartow, Earle B. Phelps, H. P. Corson, C. P. Hoover, E. H. S. Bailey.

F. W. Bruckmiller: *The Use of Benzidene for Sulfates in Water Analysis.*

Edward Bartow and A. N. Bennett: *The Determination of Arsenic in Filter Alum.*

European specifications require that filter alum be free from arsenic. This suggested an investigation of filter alum used in the United States. Samples collected from plants in Illinois showed not more than 4 parts per million of As_2O_3. Since the Illinois plants are supplied from western manufactories, samples were obtained from plants throughout the east. Larger amounts of arsenic were found in some of the specimens obtained. Only traces of arsenic were found in water treated with alum, containing the highest amount of arsenic found. While this would indicate a strong possibility that the presence of arsenic in filter alum is not significant, the authors would recommend that preference be given to alums with a low arsenic content.

C. P. Hoover: *The Manufacture of Alum at the Columbus Water Softening and Purification Works.*

The process most generally employed to-day for coagulating and purifying water contemplates applying to the water under treatment a solution of aluminum sulfate. The cost of this chemical varies from $17 to $20 per ton.

A plant for making alum has recently been built and put in service at the Columbus Water Purification Plant. This is the first plant of its kind ever built at a water purification works for making alum to coagulate water, and, although it has only been in operation a short time, it has been a success both technically and economically. The process is short, simple and inexpensive, because it consists simply in boiling bauxite with sulfuric acid and applying the resultant solution to the water under treatment, thus eliminating five distinct steps in alum-making, namely: filtering, concentrating, crystallizing, grinding and redissolving. An investment of $12,000 was required for its construction, and it has been conservatively estimated that $6,000 per year will be saved the city in the cost of alum. Between 800 and 1,000 tons of alum will be manufactured during the coming year at a cost of about $10.50 per ton.

Arthur Lederer: *Determination of the Biochemical Oxygen Demand by the Saltpeter Method in Stockyards, Tanneries and Corn Products Waste.*

The saltpeter method was originally described by Lederer in the *Journal of Infectious Diseases*, 14: 482 (1914). In short, the method depends upon the denitrification of a sodium nitrate solution when incubated for a definite period (10 days at 20° C., or 5 days at 37° C.) with sewage or polluted water. The residual nitrite-nitrate oxygen is determined analytically. The method permits a comparison of the strength of sewages from the deoxygenation standpoint. The oxygen demand of domestic sewages usually varies between 100 and 300 p. p. m. of oxygen. The method can be applied to slaughter-inghouse wastes without modification. The oxygen consumption of the Chicago stockyards waste in the Center Av. sewer fluctuates around 1,000 p.p.m., 20 per cent. of which is consumed during the first twenty-four hours. The oxygen demand of combined corn products waste fluctuated between 400 and 1,200 p.p.m., approximately 7 per cent. of which was used up in the first twenty-four hours. In this and in tannery waste the presence of lime or acid should be guarded against. If free lime is present it must be neutralized with dilute hydrochloric acid previous to incubation with sodium nitrate. If acid is present neutralize with sodium bicarbonate. The oxygen demand of a calfskin tannery waste investigated fluctuated between 400 and 1,000 p.p.m., 7 per cent. of which was used up in the first twenty-four hours. If a waste is sterile or devoid of sewage bacteria "seed" it with a few c.c. of sewage or polluted water. The general principles brought out in the work with the wastes mentioned can be applied to other wastes.

Earle B. Phelps: *Ventilation Studies.*

Edward Bartow and F. W. Mohlman: *Purification of Sewage by Aeration in the Presence of Activated Sludge.*

Domestic sewage from the city of Champaign has been treated according to the method suggested by Ardern and Lockett.[3] When raw sewage is aerated without the addition of sludge ammonium nitrogen is replaced by nitrite nitrogen, the nitrite nitrogen in turn being replaced by nitrate nitrogen. In the presence of sludge, the nitrite nitrogen is never present in large quantities. Ammonium nitrogen is apparently changed directly to nitrate nitrogen. The time of nitrification is reduced from fifteen days to four hours. The predominant organism in the sludge is an annelid worm, known as *Aeolosoma hemprichi*, although other microscopic animals are present. The sludge

[3] *Jour. Soc. Chem. Ind.*, 33: 523–39; 1,122–24.

does not have an unpleasant odor, although it will putrefy if kept for a long time in a moist condition without air. The dried material contains 6 per cent. of nitrogen; 1.44 per cent. of phosphorus. These figures would indicate its value as a fertilizer, which fact has been confirmed by pot cultures. Portions of the dried sludge showed excellent growths of wheat at the end of 18 days. The experiments are being continued on a larger scale.

RAY C. WERNER: *Sanitary and Mineral Properties of the Water Supplies of Georgia.*

A sanitary water laboratory was established by the Georgia State Board of Health in May, 1910, and a sanitary survey of public water supplies undertaken. The work has been limited, due to lack of funds, but about thirty water works plants have been inspected and analyses have been made from most public supplies of the state. The interest of superintendents and other officials of water works is growing and some water works laboratories are being installed in the state. Mismanagement and lack of understanding of technical features of purification leads to poor filtering results in some cities.

Supplies of the state are in general: Filtered stream waters in northern half and deep wells in southern section. The stream waters are usually turbid and more or less colored, but are not grossly contaminated. These waters are soft. The deep well waters are excellent in appearance and sanitary quality, and are fairly high in mineral contents, but few if any are treated for softening before use.

W. L. STEVENSON and others: *Analytical Methods for Sewage Works Operation.*

JOHN L. PORTER: *The New Orleans Water Purification Works.*

H. P. LETTON: *Rat Proofing of Wharves as an Anti-plague Measure.*

H. E. HALE and T. W. MELIA: *A Comparison of Methods for Determining Putrescibility or Oxygen Demand.*

E. J. TULLY: *A Sanitary Survey of Lake Michigan together with a Study of Stream Pollution along the Wisconsin Shore.*

It is established as a result of this investigation that the water of Lake Michigan along the Wisconsin shore is not a uniformly safe source of supply. The water is polluted and at times quite heavily so, not only in the immediate vicinity of sewer outfalls, but throughout the entire literal area studied, even to a distance of seven miles from shore, and municipal supplies are frequently more or less polluted.

It is therefore recommended that all public water supplies be purified and it is advised that sewage be subjected to adequate treatment before disposed by dilution.

DIVISION OF ORGANIC CHEMISTRY

F. B. Allan, *chairman*

C. G. Derick, *vice-chairman and secretary*

The division of organic chemistry held its meetings in Parlor "E" of the Grunewald Hotel, Friday, April 2, 1915, with Vice-chairman C. G. Derick presiding. Of the thirty-two papers listed, fifteen were given by the authors, eleven by abstracts and the remaining six by title only. Each paper was very freely discussed although the average attendance at morning and afternoon meetings was only fifteen.

EDWARD KREMERS: *The Classification and Nomenclature of Organic Compounds.*

VICTOR P. LEE: *Dimethylsulfate as a Methylating Agent.*

Many methyl ethers have been prepared with the object of determining their value, if they possess any, either as perfume substances, or as diluents or softeners when mixed with other synthetic perfume substances. The use of dimethylsulfate for this purpose is not new but has not been used much until quite recently. As dimethylsulfate is now a comparatively cheap reagent, and as its use as an alkylating reagent is very simple, it is replacing methyl iodide to a great extent. A table of the compounds prepared is given and the method used is outlined.

FRANCIS D. DODGE: *Some Derivatives of Coumarin.*

The author has prepared addition compounds of coumarin with the acid sulphites of sodium and potassium. These are well crystallized salts, and are to be regarded as sulphonates of hydro-coumarin. On heating, they decompose smoothly into coumarin, alkaline sulphite and sulphurous anhydride. They combine quantitatively with one molecule of alkaline hydroxide, yielding sulphonates of ortho-hydro-coumaric acid.

The latter are very soluble salts, showing little tendency to crystallize, and by the action of strong alkaline hydroxides, at 100°, are converted into

salts of ortho-coumaric acid. These reactions afford a very convenient method for converting coumarin into coumaric acid.

By the action of acetic anhydride at the ordinary temperature, the sulphonate of hydro-coumaric acid reverts to the hydro-coumarin sulphonate, so that by this series of smooth reactions it is possible to pass at will from coumarin to coumaric acid, or *vice versa*.

An analogous compound of Limettin (dimethoxy-coumarin) with sodium bi-sulphite is described.

The author also calls attention to the characteristic behavior of the coumarins on hydrolysis, which may be of diagnostic value for compounds of unknown constitution.

L. F. Augspurger: *The Isolation of a Blue Hydrocarbon from Milfoil Oil.*

The blue color of certain volatile oils has long attracted attention, but thus far appears to have escaped rational chemical investigation. Thanks to the distillation of more than a liter of volatile oil of *Achillea millefolium* by Professor E. R. Miller last summer, the writer had several hundred cubic centimeters of the high boiling intensely blue fraction placed at his disposal. Thanks also to the observation made by Mr. A. E. Sherndal in the laboratory of Dodge and Olcott, that an artificial blue oil combines with phosphoric acid to form a labile addition product from which the blue hydrocarbon oil can be recovered by the addition of water, it became possible for the first time to isolate the blue substance of a natural oil in a pure state.

Analysis of the compound thus isolated revealed the composition $C_{15}H_{18}$. It will be seen at once that whereas this hydrocarbon has the same number of carbon atoms as have the sesquiterpenes, $C_{15}H_{24}$, its hydrocarbon content is much lower, hence it is less saturated. The most interesting observation of the investigation thus far is that the blue color is lost upon additions to the molecule. Apparently it makes no difference whether hydrogen is added (reduction with palladium hydrogen), phosphoric acid, or possibly other substances still to be tested.

Nellie Wakeman: *A Possible New Terpene from Monarda Punctata.*

Although Schumann in 1896 reported the presence of cymene, and Hendricks in 1899 that of limonene as results of the preliminary investigation of this oil, the subsequent study of larger amounts seemed to add to the complexity of the chemical study of the oldest of the *Monarda* oils.

A large amount of the non-phenol constituents of horsemint oil having been placed at the disposal of the writer, a more careful study was made of the hydrocarbon fractions than before. All endeavors to make the hydrocarbon which yields a nitroso chloride correspond with one of the known terpenes have failed. The melting point of its nitrol piperidine differs by 103 and 87 degrees respectively from that of limonene and dipentene and by 78 degrees from that of pinene. The benzylamine base shows no such striking differences. With aniline, however, it does not react as does limonene but resembles pinene.

As soon as new material that is now being prepared for further nitroso chloride experiments is ready, a third attempt to identify this hydrocarbon with known terpenes will be made. For a summary of the chemical studies of the *Monarda* see Bulletin 448 of the University of Wisconsin.

C. H. Herty and D. H. Killeffer: *The So-called Alpha and Beta Isomeric Resin Acids.*

Oliver Kamm and C. G. Derick: *The Structure of Certain Hydronaphthoic Acids.*

The evidence previously advanced for the structure of the isomeric dihydro-β-naphthoic acids was based upon the reactions of their dibromides. A study of the oxidation products from these unsaturated acids has verified the conclusions previously advanced.

C. G. Derick and Oliver Kamm: *The Correlation of Ionization and Structure in Unsaturated Acids.*

Conclusions are drawn chiefly from acids having the unsaturation in a ring structure, thus eliminating the possibilities of cis-trans isomerism. The effect of conjugation of double unions is shown and the method of determining the constitution of acids of unknown structure is indicated. The possibility of obtaining a quantitative expression for conjugation of Thiele's partial valences is expressed.

Oliver Kamm: *Some Tests for Qualitative Organic Analysis.*

Several tests used in the courses in qualitative organic analysis at the University of Illinois are mentioned.

1. The identification of the volatile fatty acids by means of a method based upon that advanced by Duclaux for quantitative work.

2. A test for aromatic amines based upon the fact that the oxalates of most primary aromatic amines are only sparingly soluble in water while those of secondary and tertiary amines are soluble. Many of these oxalates may be titrated quantitatively, thus assisting in the identification of the amines.

3. A rapid test for the nitro group by reduction with sodium amalgam is discussed.

W. F. MONCREIF, JR., and J. T. MCGILL: *Qualitative Organic Analysis.*

An account is given of the development of systematic qualitative organic analysis; the methods used by some of the workers in this subject are compared; and the status of the subject in the curricula of a number of American colleges and universities is discussed. Emphasis is laid upon its advantages as a supplement to the usual organic preparation work.

E. C. WHITE and S. F. ACREE: *Recent Progress in the Study of the Quinone Phenolate Theory of Indicators.*

By the use of phenosulphonaphthalein it has been possible to show that a solution of the monobasic salt of the structure

(I) $(NaO_3SC_6H_4)C(:C_6H_4:O)\ (C_6H_4OH)$

is not deeply colored as compared with that of the diabasic salt

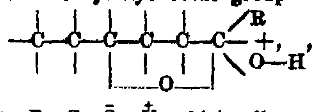
(II) $(NaO_3SC_6H_4)C(:C_6H_4:O)\ (C_6H_4ONa)$.

The monobasic salt has precisely the same color as the free acid, as is shown by titrating the acid with alkali (experiment performed at the meeting) as well as by a study of the adsorption spectra of solutions of the acid, the monobasic salt, and the dibasic salt (spectrophotographs shown at the meeting). The acid and the monobasic sulphonate are orange colored in solution, whereas the dibasic salt is purple. The former two substances already have a quinone group, but as the intense color does not appear until the dibasic salt is formed, it is clearly demonstrated that not the quinone alone, but the combination of quinone and phenolate groupings is the cause of the intense color.

The effects of substituent groups on the acidity of the phenol and sulphonic acids, and the relations of these effects to color in the acids themselves and their salts are being studied. The results secured up to this time with the tetrabrom and tetranitro derivatives indicate that the significant color changes are associated with the formation of the complex *quinone phenolate anion* $RC(:C_6H_4:O)(C_6H_4O)$.

S. F. ACREE: *A Theory of the Unsaturation of Sugars and their Derivatives by Acids and Alkalies.*

In the mutarotation of sugars and their derivatives, the catalytic activity of the hydroxyl ion depends upon the formation of an anion of the characteristic lactonyl hydroxide group



analogous to $R{-}\underset{\underset{O}{\|}}{C}{-}\bar{O}{-}\overset{+}{H}$ which all sugars possess if they show mutarotation by alkalies. When this lactonyl hydroxyl is used up in glucoside formation such anions can not form and no mutarotation by alkalies occurs.

The catalytic activity of the hydrogen ion is believed to be due to the formation of an oxonium salt of the lactonyl hydroxide group or its alkyl, corresponding anilide, etc., derivatives. That a di- or tri-basic, etc., oxonium salt is not the *active* salt in mutarotation by acids is shown by the fact that the increased velocity of the reaction is proportional to the first power of the concentration of the hydrogen ion instead of the second, third, etc., powers.

This theory has been extended to the Walden inversion, the rearrangement of such substance as *δ* and *l* menthone and many cases which logically follow as details of this theory.

S. F. ACREE: *On the Reactions of both the Ions and Molecules of Acids, Bases and Salts. A Reinterpretation of the Reactions of Sodium Methylate and Sodium Ethylate with 1, 2-Dinitrobenzene, 1, 2, 4-Dinitrochlorbenzene and 1, 2, 4-Dinitrobrombenzene.*

The data of Heclit, Conrad and Brueckner, and of Bruyn, Steger and Lulofs on the reactions of sodium methylate and sodium ethylate with aliphatic and aromatic alkyl halides and nitro derivatives can be reinterpreted on the basis of the writer's theory that both the ions and the molecules of acids, bases and salts are chemically active. When the reaction velocities obtained by these workers and our conductivity data are applied to our equation $K_N = K_i\alpha + K_m(1-\alpha)$ we se-

cure excellent constants for K_i and K_m, the activity of the ethylate or methylate ion, and the non-ionized sodium ethylate or methylate respectively.

G. D. BEAL and H. F. LEWIS: *Studies on Alkaloidal Salts. I, Strychnine Salts.*

Preliminary notice of the work being done at the University of Illinois, under the auspices of the Pharmaceutical Research Fund.

Methods of alkaloidal assay by the use of immiscible solvents are being studied. Salts of strychnine with tartaric, hydrochloric and sulphuric acid have been made and their solubilities investigated. Solvents used were ether, chloroform, water-saturated chloroform, alcohol and water. The distribution coefficient was determined using the formula $C'/C''=d$, C' being the concentration of the salt in the chloroform layer, C'' the concentration of the salt in the aqueous layer. This was done with both neutral and acid solutions of the salt with chloroform.

C. S. HUDSON and J. K. DALE: *A Comparison of the Optical Rotatory Powers of the Alpha and Beta Forms of Certain Acetylated Derivatives of Glucose.*

After careful purification, the alpha and beta forms of glucose pentacetate (molecular weight 390) were found to have the specific rotations $+102°$ and $+4°$, respectively, in chloroform. The corresponding alpha and beta forms of tetracetyl methylglucoside (m. w. 362) showed $(\alpha)_D^{20}=+131°$ and $-18°$. The *sum* of the molecular rotations of the alpha and beta forms is thus 41,300 for the glucose pentacetates and 40,-900 for the tetracetyl methyl glucosides. The agreement conforms to theoretical considerations. The paper appears in full in the *Journal of the American Chemical Society.*

C. S. HUDSON and J. M. JOHNSON: *The Isomeric Alpha and Beta Octacetates of Maltose and of Cellose.*

By heating the beta octacetate of maltose, of m.p. 159–60°, with acetic anhydride and zinc chloride, it was transformed to the new isomeric crystalline alpha maltose octacetate of m. p. 125°. The specific rotations in chloroform are $+122°$ for the alpha form and $+63°$ for the beta. After careful purification, the known alpha and beta octacetates of cellose show $(\alpha)_D^{20}=+41°$ and $-15°$, respectively, in chloroform. The *difference* of the rotations of the alpha and beta forms is thus 59° for maltose octacetate, 56° for cellose octacetate, and 57° has been found previously for the forms of lactose octacetate. From the rotation of the glucose pentacetates, the value 56° may be calculated. The four pairs of substances are thus in excellent agreement with theory. The paper will be published in full in the *Journal of the American Chemical Society.*

C. S. HUDSON and J. K. DALE: *The Isomeric Pentacetates of Mannose.*

The expected form of mannose pentacetate has been prepared in a crystalline state by the method described in the preceding abstract. The new isomer melts at 64° and shows dextrorotation $(\alpha)_D^{20}=+55°$, in chloroform. Fischer found the beta pentacetate to melt at 117.5° and to show $(\alpha)_D^{20}=-25°$, in chloroform, which we have confirmed. The difference between the rotations of the two isomers is thus 80° in comparison with the value 98° found for the two forms of glucose pentacetate. Full paper will be published in the *Journal of the American Chemical Society.*

C. S. HUDSON and H. O. PARKER: *The Isomeric Pentacetates of Galactose.*

By the same method (see preceding) galactose pentacetate has been transformed to a crystalline isomer of m. p. 96° and specific rotation $+106°$ in chloroform. The new substance is evidently the alpha galactose pentacetate, since the earlier discovered form rotates $+23°$, and is thus the beta pentacetate. The difference between the rotations of the two isomers is 83°, which differs somewhat from the value in the case of the glucose pentacetate (98°), and agrees with the value found for the mannose pentacetates.

C. S. HUDSON and D. H. BRAUNS: *Crystalline D-Fructose Pentacetate.*

By acetylating very pure fructose with acetic anhydride and sulphuric acid below 0°, a beautifully crystalline pentacetate of fructose has been prepared. It melts at 109–09° and shows levorotation $(\alpha)_D^{20}=-121°$ in chloroform. Paper in full will be published in the *Journal of the American Chemical Society.*

C. S. HUDSON: *The Existence of a Third Pentacetate of Galactose.*

It is found that the acetylation of galactose with acetic anhydride and sodium acetate yields in addition to the well-known first pentacetate of the

sugar a fair amount (10 per cent.) of another crystalline substance melting at 98° and showing levorotation $(\alpha)_D^{20} = -41.6°$ in chloroform. Analysis shows it to be a new pentacetate of galactose. There are accordingly three isomeric forms of the pentacetate. Full paper to appear soon in the *Journal of the American Chemical Society.*

FRIEND E. CLARK and SAMUEL F. COX: *Some Derivatives of Chlor-methyl Ether.*

NORMAN A. DUBOIS: *Hop-seed Oil.*

CARL O. JOHNS: *Researches on Purines: On a New Synthesis of Purines. On 2-Oxy-8-Thiopurine, 2-Oxy-8-Methyl Mercaptopurines, 2-Oxy-8-Methyl Aminopurine and 2-Oxy-6-, 9-Dimethyl-8-Thiopurine.*

Mercaptopurines when treated with methylamine yield methyl-aminopurines and methyl mercaptan. The change of 2-oxy-8-methyl mercaptopurine into 2-oxy-8-methylaminopurine is offered in substantiation of this statement and the preparation of these products is described.

CARL O. JOHNS: *Researches on Thioamino Acids. On Thiohippuric Acid and Phthalyl-aminothioacetic Acid.*

Thiohippuric acid (m. p. 104°) was prepared from hippuryl chloride and potassium hydrogen sulfide. Upon hydrolysis with warm water hydrogen sulfide and hippuric acid resulted. With iodine in alkaline solution it gives dithiohippuric acid—a reaction characteristic of the thio acids. The anilide of hippuric acid is described.

Similarly, phthalyl-α-aminothioacetic acid was prepared from phthalylglycyl chloride and potassium hydrogen sulfide. It crystallizes from benzene in plates which melt at 112°. The anilide of phthalyl-α-aminoacetic acid is described.

B. G. FEINBERG: *Citral, and its Determination.*

C. G. DERICK: *The Preparation of Trimethylene Oxide.*

Since the commercial product "Blizzard" offers a cheap source for trimethylene glycol, trimethylene bromide was prepared in large quantities very cheaply from the action of 48 per cent. HBr with subsequent saturation with gaseous HBr; yields better than 90 per cent. being obtained. Trimethylene bromide heated to its boiling point with PbO gave monomolecular trimethylene oxide boiling at 52.3° under 745 mm. pressure. From the reaction flask a polymeric form of the oxide was isolated which boils at 183° under 55 mm. pressure.

Silver oxide acts with almost explosive violence upon the bromide if 100 grams of the latter is employed and only traces of the oxide are obtained.

Mercuric oxide appears to act best of all, giving mainly the monomolecular form.

C. G. DERICK and E. H. VOLLWEILER: *The Use of Trimethylene Oxide in the Grignard Reaction. The Synthesis of Normal Primary Hexyl Alcohol.*

The polymeric form of trimethylene oxide was treated with magnesium propyl bromide in ether solution. The reaction is fairly rapid, generating heat. Upon distillation with steam the *n*-primary hexyl alcohol distils and is extracted with ether from the aqueous layer saturated with potassium carbonate.

C. G. DERICK and R. W. HESS: *The Synthesis of γ-Acetylvalerianic Acid.*

Trimethylene bromide dissolved in absolute methyl alcohol is treated with one molecule of potassium cyanide. The γ-bromobutyronitrile formed is purified by fractional distillation under diminished pressure. Yield of pure product 25 per cent. It then condensed with acetoacetic ester and the resulting γ-cyanopropylacetoacetic ethyl ester is purified by distillation under 1 mm. pressure. Upon hydrolysis with 20 per cent. HCl it gives the desired acid.

C. G. DERICK and ST. ELMO BRADY: *The Ionization Constants of Certain Ketoparaffine Monobasic Acids.*

After careful preparation and purification the following acids have been measured by the conductivity with the following results: pyroracemic acid, $k_a^{22°} = 3.643 \times 10^{-3}$ (below 0.005ON); levulinic acid, $k_a^{22°} = 2.436 \times 10^{-5}$ and γ-acetylvalerianic acid, $k_a^{22°} = 2.295 \times 10^{-5}$.

The criterion "calculated Δ_e" shows these results to be accurate to one tenth of one per cent.

M. A. ROSANOFF and M. M. HARRISON: *On the Decomposition of Tertiary Amyl Esters.*

G. B. FRANKFORTER and LILLIAN COHEN: *Equilibria in the Systems of Methyl Alcohol, Ketones, Water and Inorganic Salts, Part I.*

G. B. FRANKFORTER and STERLING TEMPLE: *Equilibria in the Systems of Propyl Alcohols, Water and Salts.*

DIVISION OF PHARMACEUTICAL CHEMISTRY

F. R. Eldred, *chairman*

A. P. Sy, *secretary*

WILBUR L. SCOVILLE: *The Stability of Nitroglycerin Tablets.*

Of 22 different lots of nitroglycerin tablets kept under observation 2½ to 3½ years, those made with a nitroglycerin paste (20 per cent. nitroglycerin absorbed in 80 per cent. sugar of milk) maintained their strength except the 1/150 gr. and 1/200 gr. tablets. All tablets made with an alcoholic solution of nitroglycerin deteriorated.

Deterioration may be due to one or both of two conditions; *i. e.*, a finer attenuation of the nitroglycerin when tablets are made from an alcoholic solution, or a more desirable isomeric form of the nitroglycerin as obtained in the paste form. Further experiments will be made to determine which factor may be the more important.

JAMES H. BEAL: *Some Reasons for the Variation Clause of the Food and Drugs Act.*

The United States Pharmacopœia appropriates titles devised and used in the arts and industries and attaches to them special meanings and standards which, though sufficient for pharmaceutical purposes, are not applicable to the arts and industries in which the greater proportion of chemical products are consumed. Only by virtue of the variation clause can these products be lawfully dealt in under their own names when they comply with other than pharmacopœial standards.

The variation clause is necessary to permit improvement of medicinal products in accordance with progress in pharmaceutical knowledge. Improvements are made in these products constantly. Without the existence of the variation clause such products could not be offered under their appropriate titles until after the improvements had been recognized by a revised pharmacopœia, which might be ten years distant.

The continuance of the variation clause as a part of the food and drug law is essential to reasonable freedom in industrial and pharmaceutical chemistry, and the demand for its unconditional repeal should be resisted.

FRANCIS D. DODGE and ALFRED E. SHERNDAL: *The Composition of Oil of Cassia.*

The authors have observed that oil of cassia contains a small amount of substances soluble in alkaline hydroxide solutions, and among these have identified salicylic aldehyde, coumarin, cinnamic acid, salicylic acid, benzoic acid, and an acid, not yet identified, apparently an unsaturated one, possibly of the acrylic series.

Though small in amount, salicylic aldehyde and coumarin undoubtedly participate in the composite aroma of the oil, and it is remarkable that their presence has not been previously observed.

H. A. LANGENHAN: *The Chemistry of the Daturas. II. The Alkaloidal Content of Datura Leaves.*

The study of the *Daturas* having been assigned by the Bureau of Plant Industry to its northern station at Madison as a special subject for investigation, the garden at Madison has in recent years raised, under the direction of G. A. Russell, the government expert, as many as fifteen to twenty species and varieties of *Daturas*. Much of the material thus produced has been assayed by the writer, and the results of the assays have recently been published as a Bulletin (No. 192) of the University of Wisconsin.

The collected results of all assays published by different experimenters seemed to show that little or nothing could be expected by working along old lines. Hence the cooperation of Professor Leon J. Cole, professor of experimental breeding in the College of Agriculture, and his assistant, Mr. C. M. Woodworth has been secured for a series of breeding experiments. As a result of last summer's work Messrs. Cole and Woodworth have germinated the collected seeds and are studying the results in the greenhouse. As in previous years, the writer has determined the alkaloidal content of the leaves of the plant studied by the breeders. The results thus obtained in greenhouse and laboratory will determine the selection of the seeds to be planted in the experimental garden this coming spring.

N. R. MUELLER: *A Possible Explanation of the Reduction Phenomena Observed in Elixir of Phosphates of Iron, Quinine and Strychnine when Exposed to Light.*

By process of elimination the study of at least one of the basal problems has resolved itself to an investigation of the action of ferric iron in the form of hydroxide on citric acid under the influence of sunlight. Under these conditions the ferric iron is reduced to ferrous iron, at least in part, and goes into solution; a very small amount of the iron appears to be reduced to metallic iron, which is deposited in a very fine state of division. While the iron is reduced, the citric acid is oxidized in part with the formation of carbon dioxide. The colorless solution of iron salt or salts which thus results under the absolute exclusion of atmospheric oxygen becomes colored at once when exposed to the atmosphere, the solution turning greenish.

CHARLES L. PARSONS, *Secretary*

SCIENCE

FRIDAY, JULY 23, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

FORTY YEARS' FLUCTUATIONS IN MATHEMATICAL RESEARCH[1]

IN the year 1870 was published the first volume of the *Jahrbuch über die Fortschritte der Mathematik*, a new venture in the mathematical world. It was intended to relieve students and investigators from the necessity of searching through all available recent books and serials in the quest of any particular topic, or in the effort to keep posted on the discoveries of current interest. Similar attempts have been made, both before and since 1870, in other fields of science; and their effect and influence have been so marked that even the general reader has now Poole's Index and its successors, attempting in a less minute way the same service for general periodical literature. Under each title of book or article the *Jahrbuch* gives a brief analysis, sometimes a criticism, so that the reader follows up only those articles whose actual content proves important for him.

At the outset the expectation was confidently expressed that the *Jahrbuch* would appear within six months after the close of its year. But serials were slow in reaching the office, there were from twenty to forty referees, and once a printer's strike interposed for half a year; so that three years often elapsed instead of six months. Twice a double volume was issued in the hope of lessening the delay; but it soon fell back, and now our most recent volume covers the year 1909. These voluminous handbooks, now covering forty-two years and occupying eight feet of shelf-room, offer op-

[1] Read before the Vassar Faculty Club, and the Columbia Mathematical Colloquium, February, 1914.

portunity for certain inquiries which without them would be futile; and first, for questions quite impersonal and general.

One's first impression, on inspecting this series, is that the number of authors of books and contributors to *Acta eruditorum, Berichte der Akademie, Comptes rendus, Transactions* or *Journals* must have increased surprisingly during forty years. So we count sample volumes, say those for 1875 and 1905. In the former, the number of serials reviewed and the number of writers were, respectively, about 110 and 510; in the latter volume these numbers are 180 and 1,880. To determine more definitely the quantity of mathematical literature represented, two methods suggest themselves. One is to assume that the number of *pages* filled by those reviews is proportional, on the average, to the quantity of literature published each year; or, if it seems more reasonable, proportional to the number and importance of ideas developed. The other is to count the titles listed in each table of contents, and take those for a measure. Diagrams are here shown, giving the results of both methods, the years being set at equal intervals along a horizontal base, and their output in pages or in titles being set off upward. A broken line joins

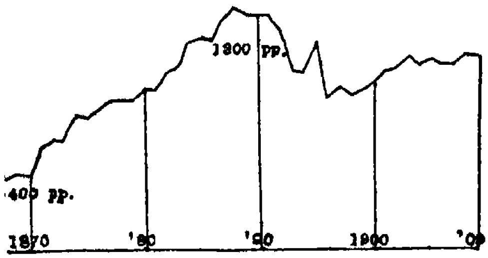


Fig. 1. *Jahrbuch über die Fortschritte der Mathematik.* Increase in size during forty years.

the points so marked; thus the area between graph and baseline, widening from decade to decade with one or two interruptions, conveys a fair idea of the growth in this kind of literature. One of the interruptions comes in the years 1893–4, where a double volume was issued in an attempt to overtake the flight of time. It shows pre-

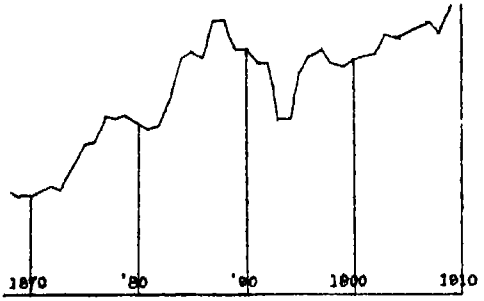


Fig. 2. Annual Number of Titles of Mathematical Articles and Books, 1868–1909.

sumably that considerable matter properly belonging in those years was pushed into the preceding and the following volume, swelling them unduly. The general impression

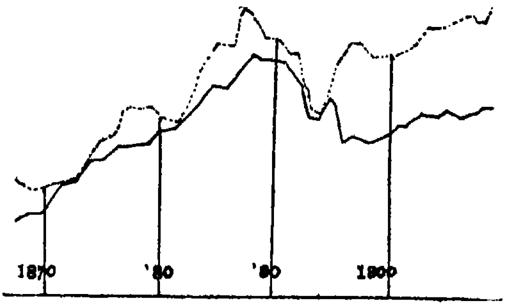


Fig. 3. Number of Pages; Number of Titles, for Comparison, in Dotted Curve.

from these two curves (if I may call them so) is that the two methods agree approximately, and that either one may be used as may be convenient. But we shall test this further on particular divisions of the science.

We see that the annual publication has doubled during the four decades, and considerably more; also that the space given to each review has decreased. Causes for the first are the increased attendance at universities, the general advance in zeal for research as a part of the great onward move-

ment in natural science, and the increase in funds available to support publication of new results. For the second fact, the condensation of reviews, it is certain that much space is saved by the possibility of reference to earlier volumes where similar articles were reported; and it may be suspected that the haste to print has given us many articles of little importance; and further, it is increasingly necessary to save the time of the reader—Fechner's law may perhaps hold here, as in the ratio between nerve-stimuli and sensations: the referees are competent, busy workers in various departments of research, and fatigue effects must be looked for in their treatment of minor matters at least.

For convenience I separate the list of contents into five principal groups, each group embracing several chapters or sections; these will suffice at least for a first study. They are philosophy and biography, algebra, analysis, geometry and applied mathematics. To any specialist this seems too coarse a division for any definite result, but we are seeking general information. Our division *algebra* includes not only the theory of equations and their systems, but also such diverse subjects as Galois groups, theory of integers and other numbers, determinants, invariants of linear substitutions, probability and series. So too *analysis* covers a long range, from the elements of differential and integral calculus to the theory of real and complex functions of one or of several variables, general and particular. *Geometry* covers both the Euclidean and non-Euclidean, synthetic and analytic, the elementary and much that is so advanced as to be hardly distinguishable from algebra or from abstract logic. So *Mechanics,* all branches of mathematical physics, astronomy, geodesy and even meteorology are combined under the single rubric, *Applied Mathematics.*

There is a possibility of testing roughly those data, by comparison through the years 1891–1909 with the *Revue Semestrille,* a briefer report issued half-yearly and with less delay by the mathematical societies of the Netherlands, chiefly of Amsterdam. The comparison can not be quite satisfactory because the *Revue* classifies one article often under several rubrics, sometimes giving six or more references by different members for an article listed only once among the *Titles* in the *Jahrbuch.* Of course the tedious process of counting titles page by page through every volume is not to be thought of. Making this allowance, I have prepared with the help of Dr. Cowley, a collaborator on the staff of the *Revue,* graphs showing the numbers of

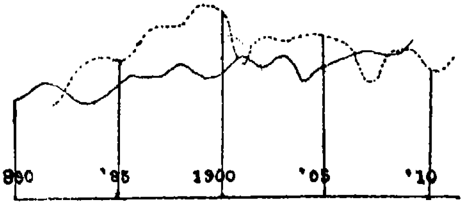


FIG. *A.* Algebra, Titles. *Jahrbuch,* Solid; *Revue Semestrielle,* Dotted Curve.

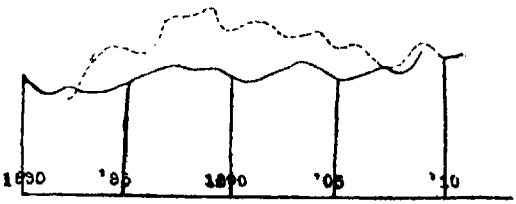


FIG. *B.* Analysis, Titles. *Jahrbuch,* Solid; *Revue Semestrielle,* Dotted Curve.

titles listed by both reports in the four topics, excluding philosophy and biography.

These may be considered satisfactory confirmation of the others, if we make two or three assumptions or observations. First, the scale adopted for comparison is probably too great on the *Jahrbuch* side. Titles here were measured in inches, and have

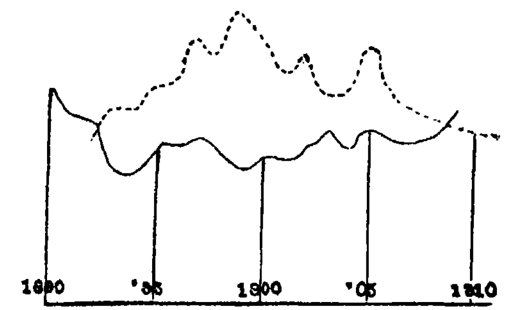


FIG. *C*. Geometry, Titles. *Jahrbuch*, Solid; *Revue Semestrielle*, Dotted Curve.

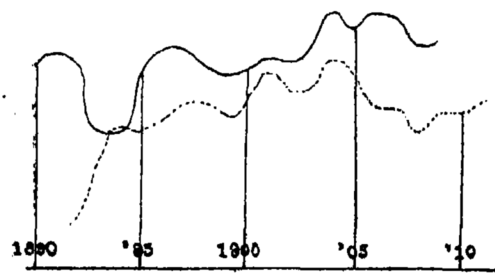


FIG. *D*. Applied Mathematics. *Jahrbuch*, Solid; *Revue Semestrielle*, Dotted Curve.

been plotted as containing 10 to the inch. By random samples it appears that 7 or 8 would have been nearly correct. Second: If by this correction the *Jahrbuch* curve were lowered relatively, still the divergence would be disproportionate for different years; less in earlier and later years, greater near the middle of the period. As to this, it is possible to surmise that the frequent change in the *personnel* of the staff, together with the fact that each one turns in reports on all the contents of his assigned periodicals rather than upon a list pertaining to his own few specialties, will explain much of the observed effect. In the first few years habits of work were not yet settled, and after several years it may easily have happened that cross-references of minor importance were found too numerous for utility and gradually reduced. Probably, thirdly, irregularities due to postponement or to lack of prompt arrival of publications would affect the *Revue* more markedly than the more leisurely *Jahrbuch*.

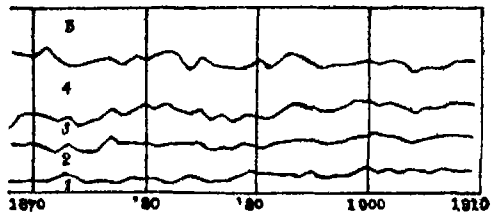
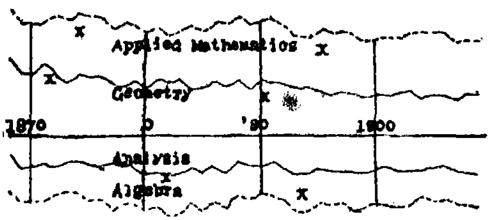


FIG. 4. Proportions of Titles in Large Divisions. (1) Philosophy, (2) Algebra, (3) Analysis, (4) Geometry, (5) Applied Mathematics.



FIGS. 5–6. Proportional Numbers of Titles in Four General Divisions of Mathematics. (*x*, Maxima.)

I show graphs of the proportionate amounts (*i. e.*, percentages) of the successive volumes, that fall into the several divisions; the first with boundaries straight and parallel, like covers of a book, the second with a straight line separating the abstract algebra and analysis on one side from the more concrete geometry and applied mathematics on the other. In this latter the outer boundaries are parallel curves, and their fluctuations enable us to trace the occasional shift of interest toward concrete or abstract.

On this diagram it is noticeable that the proportions of writings in the different divisions are by no means constant. Roughly estimated, the averages are: Applied mathematics 30 per cent., geometry 25 per cent., analysis 20 per cent., algebra 18 per cent. and philosophy, history, etc., together 7 per cent. But there are certain times of wide variation from the average. In physics, for example, there is a period of increase from 1883 to 1890, a time when Maxwell's "Electricity and Magnetism," Rowland's researches in the spectrum,

Helmholtz's Faraday lecture, and certainly the influence of Thomson and Tait's great treatise on "Natural Philosophy," might help to explain the rapid growth of interest and discussion. The lesser, though well marked, influx of energy in the years following 1895 may be due in part to the discovery of radium and the new theories of electrons and atoms. Of course such surmises can only be verified or corrected by close examination of the subjects that are grouped together indiscriminately in this division.

Such fluctuations occur not only in these most concrete branches, but are discernible in all the others. Such variations in the choice of subjects for investigation one is tempted to call changes of fashion, so capricious or accidental do they appear to a superficial observer. On this same diagram, in geometry, note the disproportionate breadth of the stream through the '70's, and its slow narrowing thereafter. See in analysis, too, the breadth near 1880, and later, some expansion soon after 1890. Algebra enjoyed maximal periods not far from 1878, and has overflowed its usual boundaries again ever since 1899. The gradual augmentation in philosophy, history, biography might have been expected, but is also in part traceable to the influence of imitation and to vagaries in classification.

One may pick flaws in classification, but there are excuses, one of them in this very fact of changing fashions. For a set of categories that answer well enough in 1868 do not contain explicitly all the topics that interest even conservative mathematicians in 1880, still less in 1910. No long disquisition on this subject is needed, for nearly every one has some pet grievance against a much more elaborate arrangement, the Dewey system of classification of books. But also a part of the fault, in the case before us, lay in the imperfect office arrangements even more than in the system adopted. Against this source of error the more recent French system has guarded, by adopting numbers for a designating mark. Of course the *Jahrbuch*, published in Berlin, ignores this improvement, but it does from time to time add new titles to chapters and new subdivisions under them. My two complaints against the editors were first their lack of discrimination between two subjects called by the same name: theory of forms in the algebra of continuous variables, and theory of forms in the domain of whole numbers or integers. When looking for important memoirs on the one subject, one must always search with a careful eye the other chapter also. And in the second place they had made no place for any *Theory of Groups* except that concerned with permutations (hardly even for that until very recent years), and ignored completely the creation of a great new department of activity by *Sophus Lie* in 1870, under the same caption with a difference, viz., the "Theory of Continuous Groups."

In all this tabulation and construction of graphs, it has been assumed that one article is like another in importance, one idea as fertile as its rival, one name of an investigator no more to be noticed than any other. This assumption, however, is harmless, for it deceives nobody. As well try to convince a student of stars that all parts of the nightly sky are of equal brightness, that there are no luminaries of first magnitude and no Galaxy resplendent with its organized myriads! But in a first approximation we are at liberty to make errors, provided we do so with the consciousness that they are errors and that they call for subsequent discrimination and revision.

Look then at a few graphs relating to single divisions or subdivisions.

In 1868 and 1869 was published an epoch-making work, the "Geometry of Straight Lines," by Julius Plücker, professor of physics and mathematics at the University of Bonn. Unconsciously students of geometry had presumed that the space we live in must be conceived as built up of points, or minute bodies, having vanishing magnitude or dimension in all directions. Plücker pointed out that to the eye of pure mathematics it is just as true that space is built of *straight lines*. The intersection of the lines of geometry is no obstacle to such a theory, any more than if they were rays of starlight! With this new conception of space, amenable to a beautiful algebraic treatment, came a great stimulation of speculation and exploration in geometrical realms both old and new. *Plücker,* his brilliant pupil *Klein, Clifford* and *Cayley* are the centers of greatest energy in this movement, whose force persisted for twenty years and more. I show here a graph for geometry, no longer as a

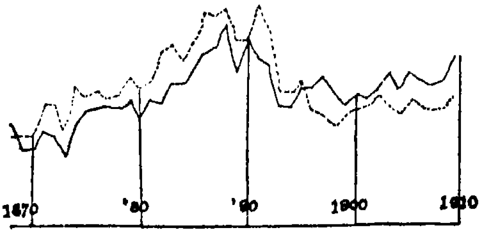


Fig. 7. Geometry, Number of Titles; Number of Pages, for Comparison, shown by Dotted Curve. Agreement, fair.

greater or less part of the entire range of mathematics, but measured, so to say, absolutely—the number of titles or of pages given to it in each annual volume of the *Jahrbuch.* Judged upon either basis, geometry seems to have doubled in rate of production from 1870 to 1890, then to have fallen off a third, to regain most of this loss after 1899.

In the universities of Germany the decline was decidedly more violent than this graph can show; for men trained in a specialty do not all change suddenly their interest or their line of study. So the new impulse, if it comes, will lag in its manifestation on this graph. Geometry was transplanted into Italy during the '80's, and the notion of *Group,* worked out in partial applications earlier by Klein, Sophus Lie, and their schools, was extended, energized and developed in larger geometric shape by young, ardent, brilliant sons of the men who in 1870 had created a new kingdom of Italy. A new society began to publish *Rendiconti* at Palermo ('88) and we note the point, about 1893, where this rising tide meets and overcomes the ebb of the German wave, Segre is here the great name, at first; Castelnuovo and Enriques soon rise to altitudes before unknown, algebraic *surfaces* now proving to be no less interesting than algebraic *curves* had been in the 70's and 80's.

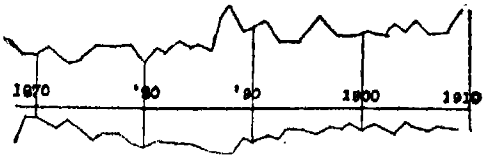


Fig. 8. Above, Analytic Geometry, Titles; Below, Modern Synthetic Geometry (same scale).

Let us further distinguish, dividing geometry into the pure or synthetic, and the algebraic. Both had experienced revival in Germany, the synthetic geometry through a combination of influences, conspicuously through the publication of *Reye's* lectures in form pedagogically perfect, with full illustration and touched with that scientific fire which is almost poetic inspiration. Our graph is arranged to show on opposite sides of a base-line, by numbers of titles, the output of analytic and algebraic geometry above, the synthetic below. The ordinates are absolute, not percentages; and further argument is unnecessary to estab-

lish the thesis that research is ruled partly by fashion; the maximum of synthetic work about 1887, and its decline through

FIG. 9. Analysis, Pages; Titles, Dotted Curve. Both show a maximum about 1886, a minimum about 1895.

the following twenty years, is proof sufficient.

One graph shows the growth of what is called *analysis*, that great body of knowledge which takes its rise equally from calculus, from the algebra of imaginaries, from the intuitions and the critically refined developments of geometry, and from abstract logic: the common servant and chief ruler of the other branches of mathematics. The page-chart solid, the record of titles broken, both show a general increase in the amount of work, possibly a trebling in forty years. A first maximum appears before 1890, probably the culmination of waves

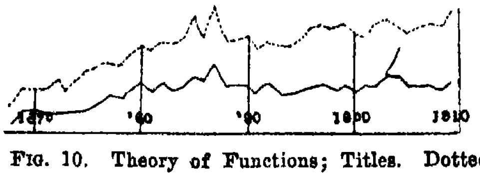


FIG. 10. Theory of Functions; Titles. Dotted Line: Analysis (Reduced).

set in motion by *Weierstrass* and *Fuchs* in Berlin, by *Riemann* in Göttingen, by *Hermite* in Paris, *Mittag-Leffler* in Stockholm, *Dini* and *Brioschi* in Italy. The great energy of these giant intellects was directed mainly to founding on a basis critically unassailable the theory of functions, before this time somewhat loose and uncertain, and to developing its particulars from general grounds, rather than by piecemeal as was the necessity earlier. So in the next graph we see how considerable a part of the growth of analysis prior to 1887 was due to activity in this—its central part, the theory of functions. But the fashion changes, and a new sweep of the curve upward does not occur until after 1900, when a new impulse comes from the theory of integral equations (not yet recognized as a separate field by the *Jahrbuch* editors) and from the influence of another master mind, *Hilbert* of Göttingen. In our own country too this branch of science is forwarded, notably at Harvard, Chicago and Yale.

One more example is perhaps the most striking of all. *Algebra* is shown first,

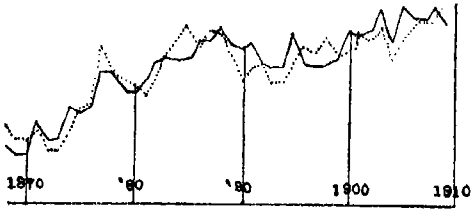


FIG. 11. Algebra, Including Series and Groups. Solid Line, Pages; Dotted Line, Titles.

pages on a solid curve, titles on a dotted one, quite nearly in accord. Each decade has its chief new subject for expansion, and growth is not far from steady. Equations, now up to the seventh and eighth degrees: determinants, invariants of linear groups of operations, and substitution groups all have had their years of plenty under this curve, and give it a strong, well-grown look. The part of this work that was shared most largely by our own countrymen is the theory of algebraic forms, quantics or invariants and covariants, as it is variously called. *Sylvester*, first professor of mathematics at Johns Hopkins University, had done fundamental work in this field in his youth, in the early 50's. At Baltimore the

eager requests of students led him back to that line of research, and many joined him in producing extensive and valuable work; much of it published in the *American Journal of Mathematics,* which he founded. In Germany the same subject engaged attention, at the same time or a little earlier, through the efforts of *Aronhold* at Berlin—a true pioneer; of *Clebsch* at Göttingen and *Gordan* at Erlangen, the last two founding in 1869 a new journal, the *Mathematische Annalen,* to facilitate the publication needed for the work of themselves and their enlarging circle of progressives.

The rapid rise, the climax and the decline to a low normal, in this theory of forms or *invariants,* is shown in a graph which amply repays this rapid statistical study.

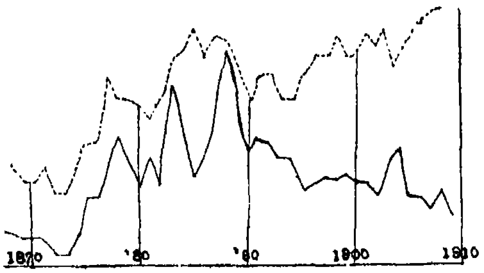


Fig. 12. Algebraic Forms, Invariants, etc.: Titles. Algebra, including Number-theory and Groups, Above (Reduced).

The solid curve shows the annual number of titles, while the dotted graph above, on smaller scale, shows how the general division, algebra, was fluctuating. Here the fashion reaches its acme before 1890, an increase twice as rapid as that of the main division; and declines most surprisingly. Sylvester returned to England in 1884; and in Germany a climactic series of discoveries by Hilbert set a temporary high mark, discouraging further effort for the time. But a later maximum, 1905, has in it a guarantee that growth is not impossible; this I do not pretend to explain, but the fact is obvious.

The field of differential equations has always held attraction for mathematicians, principally because of its close contact with physics and geometry. Its development naturally waited for that of the theory of functions. We see the researches in this

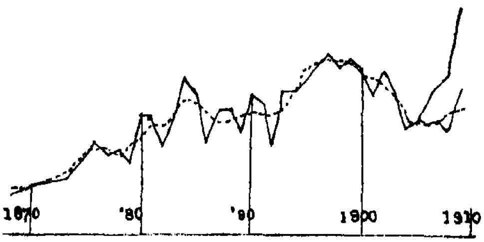


Fig. 13. Differential Equations: Titles. The dotted curve is averaged for three years.

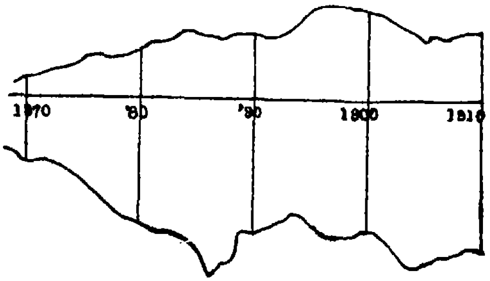


Fig. 14. Differential Equations Above; Below, the Residue of Analysis, Number of Titles.

department increasing in number slowly from 1870, under the combined influence of Weierstrass, Darboux and Lie; and note a slight decline about 1886, followed by a marked recovery and advance during the publication of lectures by Forsyth, Picard, Goursat and Painlevé. It is of interest to see the relative variation in differential equations on the one hand, and all the rest of analysis on the other.

Finally we examine in a separate diagram the fluctuation in absolute quantity of work on the mathematical theory of electricity and magnetism, and its ratio to the whole of applied mathematics. It remains less than one fourth of the whole, but rises after 1873

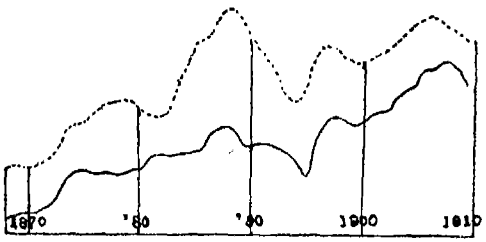


FIG. 15. Electricity and Magnetism; Dotted Line, Applied Mathematics (½ scale).

fairly steadily toward that fraction. It has been mentioned already that 1873 was the year of publication of Maxwell's "Electricity and Magnetism," and of Thomson and Tait's "Natural Philosophy." Maxwell's book appears in German translation in 1883. About 1880 Hertz began his remarkable experimental work verifying the theories of Faraday and Maxwell, with effects certainly contributory to the swelling of this tide. An apparent ebb near 1894 is explained in part by the increasing preoccupation of the referee in that department. Immediately after that date the increase of matter is resumed, partly under the new stimulus of Röntgen rays (1897) and of the electron theory (about 1902). By comparison, this special impulse seems not to be shared by the other departments of applied mathematics.

A careful inspection of these graphs might lead some specialists to lament the constant shifting of the center of mathematical interest. To students, however, who are about embarking on the sea of research, it may yield such profitable hints as the mariner draws from a chart of prevailing winds and currents. H. S. WHITE

VASSAR COLLEGE

NICHOLAI ALEXEYEVICH OUMOV

THE recent death of Professor Nicholai Alexeyevich Oumov deprived Russia and the world of one of those remarkable men, unfortunately rare in our age of sharply defined specialization, in whom the powers of analysis and synthesis were so well blended together, as to enable him to be more than simply a great physicist, or a great chemist, or a great cosmographer, but a great philosopher.

It seems that modesty is a usual attribute of greatness, and Oumov was a modest man, indeed. Perhaps this accounts for the fact that he is so very little known in this country and in England, although the continental Europe, especially Germany, knows him well and has a profound respect for his works. His biography, however, seems to be a matter of knowledge only within a small circle of his countrymen, and it seems desirable to supply this want.

Oumov was born in 1846. To his father, a physician by profession, he owes his profound and wide interest in physical science. At the age of twenty-three he was graduated by the faculty of physics and mathematics of the University of Moscow. After his graduation he entered the car-construction works of Williams and Buchteeff. Later on he registered at the St. Petersburg Technological Institute, but after two months' attendance, he received an offer to return to the University of Moscow and prepare for a professorship there.

In 1871, however, he received appointment as a privat-docent in physics at the University of Odessa, where, several years later, he was promoted to professorship. In 1893 he was transferred to the University of Moscow, where he lectured successively on general, mathematical and experimental physics.

In 1905 the Russian universities received a charter of autonomy, by which the administration of the institutions was left in the hands of the university council, while the student body received certain privileges of self-government. However, towards the end of 1910, when the late Kasso became the Russian minister of education, attempts were made to deprive the universities of their autonomy. Early in 1911 a strike of the Moscow students, provoked by the agents of the police, as was later determined, gave the government the desired opportunity, and police control over the

internal affairs of the Moscow University was established.

The rector of the university, Dr. Manouilov, went to St. Petersburg to protest against this, pointing out the fact that the administration of the university was able to take the proper measures, without police interference. He was informed by the minister that if the state of affairs, as it then existed, did not please him, he was at liberty to pursue any course he chose.

Immediately upon his return to Moscow, Dr. Manouilov resigned from his post at the university. Several other professors, led by Oumov, also tendered their resignations, as a protest against the action of the government.

At that time Oumov, as the professor of experimental physics, was in charge of the celebrated physical institute of the university. Several days after he tendered his resignation, he was ordered to leave the university *immediately*. He was not even permitted to complete the experiments he had under way in his laboratories.

When this became known, a group of Moscow business men collected funds for the equipment of a new laboratory at the Free University of Sheniawsky, also at Moscow, and Oumov's work was transferred there. He remained at this university until his death.

This one fact is sufficient indication of the popularity which Oumov enjoyed in private life. He was beloved by his students, despite the fact that he was very exacting in his requirements. But it was well known that whenever the interests or the privileges of the student body were concerned. Oumov would always bring his powerful influence to bear upon his colleagues. Stern and dignifiedly scientific in the lecture hall and the laboratory, he was always kind, open-hearted and generous in private life. Student after student received financial assistance for the tuition from Oumov, but each one was made to promise never to mention this fact.

It is interesting that his favorite laboratory assistant, a man of scarcely any education, has recently been appointed to special instructorship at the university. His association with Oumov gave him a wonderful knowledge of physics.[1]

As far as Oumov's scientific work is concerned, it would be very difficult to give a full appreciation of it at the present time; like the majority of Russian professors he published comparatively little during his lifetime, and a considerable period will probably yet elapse before we have a complete study of his work.

There was, however, one characteristic feature of his scientific activity, of which we spoke at the very beginning. He was primarily a scientific philosopher, and it was this characteristic that made him different from other physicists. It was with a profoundly philosophical attitude that he regarded the different evolutionary phases of the human thought in the domain of physical phenomena. Professor Hvolson thus describes this characteristic side of Oumov's scientific make-up:

> He possessed a remarkable talent that enabled him to grasp quickly the essence of the views and the interpretations of the world, prevalent at the given moment, analyze the causes, often remote and deep-seated, that led to the rise of new hypotheses and theories, and then, by means of a clever synthesis, represent the results of the new evolutions of science.[2]

He was a splendid lecturer and he was often invited to speak at scientific congresses. In his speeches

> clear popular presentation of the results of new scientific works was blended with a philosophical interpretation of them, which often made them assume entirely new aspects.

The esteem in which Oumov was held by his fellow scientists in Russia may be seen from the fact that on the "First Russian Congress of Teachers of Physics, Chemistry and Cosmography," held in December, 1913, Oumov was elected president, as the "oldest Russian professor of physics, a profound thinker and a remarkable scientist." At this congress he delivered a famous speech on the "Evolution

[1] I owe these facts concerning Oumov's private life to my friend, Mr. E. Dourmashkin, of New York City, who had studied under Oumov at the University of Moscow.

[2] Professor O. Hvolson, "Retch," Petrograd, January 19, 1915.

of the Physical Sciences and Its Idealistic Significance."

His scientific activity was profound and many-sided. His splendid knowledge of physics, in the progress of which he was interested all his life, and his tremendous general erudition, enabled him to work in many departments of physical science. The names of some of his works are very suggestive of this manifoldness of interest: "A Theory of Action at a Distance and Its Application to the Laws of Electrostatics and Electrodynamics," "The Laws of the Solution of Certain Salts," "The Geometrical Significance of Frenkel's Integrals," "An Attempt of Discovering the Laws of Heat Energy in Chemical Reactions," "Über eine Methode objektiver Darstellung der Eigenschaften des polarisierten Lichtes," "The Formation of Drops in a Magnetic and an Electric Field."

In physics he was equally at home in experimental methods and in the mathematical analysis. After leaving the University of Moscow, however, he gave himself up almost exclusively to theoretical work, especially in the domain of the principle of relativity. Some of his results in this direction were described in a speech on "The Characteristic Features and Problems of the Modern Scientific Thought," delivered before the general meeting of the second Mendelejev Congress.[3]

Oumov was the president of several scientific societies in which he was invariably the guiding spirit. For a short time he edited a splendid scientific magazine, *The Word of Science*, which, however, did not exist long.

LEO PASVOLSKY

NEW YORK CITY

CLASSIFICATION OF TECHNICAL LITERATURE

DELEGATES from about twenty national technical and scientific societies met in the United Engineering Society Building, 29 West 39th street, New York City, on May 21, 1915, to perfect a permanent organization, the purpose being to prepare a classification of the literature of applied science which might be generally accepted and adopted by these and other organizations.

[3] Unfortunately the speech is not available in this country.

There was a generally expressed opinion that such a classification, if properly prepared, might well serve as a basis for the filing of clippings, for cards in a card index, and for printed indexes; and that the publishers of technical periodicals might be induced to print against each important article the symbol of the appropriate class in this system, so that by clipping these articles a file might be easily made which would combine in one system these clippings, together with trade catalogues, maps, drawings, blue prints, photographs, pamphlets and letters classified by the same system.

By request, Mr. W. P. Cutter, the librarian of the Engineering Societies' Library, and a delegate from the American Institute of Mining Engineers, read a paper on "The Classification of Applied Science" in which, after describing the existing classifications, of one of which he is the author, he stated that, in his opinion, no one of these, although having excellent features, was complete and satisfactory enough to be worthy of general adoption. He outlined a plan whereby a central office could collate all the existing classifications, and, with the help of specialists in the various national societies interested, might compile a general system, which, although perhaps not absolutely perfect, might meet with general acceptance and adoption.

Permanent organization was effected by the election of the following officers: Chairman, Fred R. Low; secretary, W. P. Cutter; executive committee; the above, with Edgar Marburg, H. W. Peck, Samuel Sheldon.

It was agreed that a special invitation to participate by the appointment of a delegate be sent to other national societies which might be interested in the general plan.

The following societies were represented by delegates: Samuel Sheldon, library board, United Engineering Society; Richard Moldenke, American Foundrymen's Association; C. Clifford Kuh, Society for Electrical Development; Cullen W. Parmelee, American

Ceramic Society; Sullivan W. Jones, J. A. F. Cardiff, American Institute of Architects; Geo. F. Weston, American Society of Agricultural Engineers; F. L. Pryor, American Society of Refrigerating Engineers; H. W. Peck, American Gas Institute; Nicholas Hill, American Water Works Association; Edwin J. Prindle, L. P. Alford, L. P. Breckenridge, American Society of Mechanical Engineers; F. J. T. Stewart, National Fire Protection Association; J. J. Blackmore, American Society of Heating and Ventilating Engineers; C. F. Clarkson, Society of Automobile Engineers; F. L. Bishop, Society for the Promotion of Engineering Education; George R. Olshausen, U. S. Bureau of Standards; E. C. Crittenden, American Physical Society; Alfred Rigling, Franklin Institute; W. P. Cutter, American Institute of Mining Engineers; Edgar Marburg, American Society for Testing Materials; A. S. MacAllister, National Electric Light Association. American Electro-Chemical Society and Illuminating Engineering Society; C. E. Lindsay, American Railway Engineering Association; G. W. Lee, librarian.

The executive committee was charged with the task of enlarging the membership of the committee to include delegates from all similar national organizations, and the preparation of a plan for further action.

The delegates present expressed most hearty and enthusiastic personal interest in any system which might be worthy of general adoption; they could, of course, not promise, at this early date, anything more than moral support to the idea, reserving for themselves and for their societies the right to thoroughly examine any system that might be evolved before recommending its adoption.

The name adopted for this organization is "Joint Committee on Classification of Technical Literature," and the temporary address of the Secretary, Mr. W. P. Cutter, is 29 West 39th Street, New York City.

THE NINETEENTH INTERNATIONAL CONGRESS OF AMERICANISTS

In consequence of the war in Europe, the Washington meeting of the Congress, which was originally scheduled for October 5, 1915, was, with the general approval of the membership, indefinitely postponed. Since then it has become evident that the war may last for a long period, and that when it does end the conditions, economic and otherwise, may be such that a successful meeting can not be held for many years. Circumstances, however, have so shaped themselves as to make possible a well-attended session of the congress during the coming winter, notwithstanding the enforced absence of most of the European delegates. During Convocation Week of this year, a number of important scientific bodies, whose interests wholly or in part are closely related to those of the Americanists and whose membership is in a large measure the same, will meet in Washington. As this seemed to present an excellent opportunity for a meeting of the Americanists, the organizing committee took preliminary steps which assure intimate cooperation between the Congress and other learned bodies and submitted the proposal to hold the postponed session in cooperation or jointly with these organizations, to the vote of the members. The result of this vote was overwhelmingly in favor of the proposal. In consequence, the organizing committee feels authorized to announce that the session will be held in Washington, December 27–31, of this year; and that it will be held jointly or in cooperation with the Anthropological Section of the Pan-American Scientific Congress, the American Anthropological Association, the American Historical Association, the American Folklore Society, and the Archeological Institute of America. The program previously published will in the main be adhered to, excepting the field excursions; and the members are urged to communicate with the secretary in relation to the papers which they intend to present.

W. A. Holmes,
Chairman, O. C.
A. Hrdlička,
Secretary

SCIENTIFIC NOTES AND NEWS

Dr. W. W. Campbell, president of the American Association for the Advancement of

Science, will deliver an address at the opening session of the Pacific coast meeting, held at the Scottish Rite Auditorium, San Francisco, on the morning of August 2. Dr. C. W. Eliot, the retiring president of the association, is unable to be present.

THE thirteenth annual session of the South African Association for the Advancement of Science was held at Pretoria, from Monday, July 5, to Saturday, July 10, under the presidency of Mr. R. T. A. Innes, union astronomer.

THE Trail award and medal of the Linnean Society for 1915 has been presented to Dr. Leonard Doncaster, and the Linnean gold medal to Mr. J. H. Maiden, of Sydney, New South Wales.

AT its recent commencement Oberlin College conferred its doctorate of science on Dr. Charles A. Kofoid, professor of zoology in the University of California.

AT a convocation of the University of Oxford on June 25 the honorary degree of master of arts was conferred on Mr. Horatio P. Symonds, surgeon to the Radcliffe Infirmary, in recognition of his services to the Oxford Medical School.

AMONG knights created on King Albert's birthday the following are given in *Nature* as those engaged in scientific work: Mr. C. E. Fryer, superintending inspector of fisheries division of the Board of Agriculture and Fisheries since 1903; Mr. R. R. Gales, Indian Public Works Department, engineer-in-chief, Hardinge Bridge, Sara, Bengal; Dr. J. Mackenzie, F.R.S., lecturer on cardiac research at the London Hospital; Dr. T. Muir, F.R.S., superintendent-general of education, Province of the Cape of Good Hope, Union of South Africa; Mr. W. Pearce, director of William Pearce and Sons (Limited) and Spencer, Chapman, and Mensel (Limited), chemical manufacturers; Mr. E. Rigg, since 1898 superintendent of the operative department of the Royal Mint; Dr. W. N. Shaw, F. R. S., director of the Meteorological Office since 1905 and reader in meteorology in the University of London since 1907; Mr. W. Slingo, engineer-in-chief of the General Post Office.

MR. HERBERT LANG has been appointed assistant in mammalogy and Mr. James P. Chapin assistant in ornithology in the American Museum of Natural History. Mr. Lang and Mr. Chapin have also been elected life members of the museum in recognition of their efficient services in conducting the Congo expedition.

A GRANT of £50 has been made from the Balfour Fund of the University of Cambridge to enable Mr. G. Matthai, of Emmanuel College, to visit America in furtherance of his researches on the comparative anatomy and classification of the Madreporaria.

DR. FREDERICK BURR LA FORGE, of the staff of the Rockefeller Institute for Medical Research, has been appointed expert in organic chemistry in the U. S. Department of Agriculture. Dr. Benjamin S. Kline, also of the staff of the institute, has been appointed resident pathologist of the Montefiore Home for Chronic Invalids, and in connection with this appointment he has also undertaken work in the department of pathology of the College of Physicians and Surgeons, Columbia University.

DR. M. SULLIVAN has resigned from the division of soil fertility of the U. S. Department of Agriculture, Washington, D. C., and has accepted the position of bio-chemist of the U. S. Public Health Service. Dr. Sullivan will be engaged in the biochemical study of pellagra with headquarters at the pellagra hospital, Spartanburg, S. C.

DR. NEVIN M. FENNEMAN, profesor of geology at the University of Cincinnati, will have his year's leave of absence next year. Dr. Guy A. Tawney, professor of philosophy at Cincinnati, will return in the fall after a year's study at Oxford, England.

DR. LATTITIA M. SNOW, associate professor of botany in Wellesley College, has been granted a leave of absence for 1915–16. She expects to study in several institutions but her address for the year will be department of botany, University of Chicago.

MESSRS. H. E. ANTHONY and D. S. BALL have returned from an expedition to the moun-

tains of the Isthmus of Darien in eastern Panama, bringing with them for the American Museum of Natural History a collection of 1,100 birds and 250 mammals, many of which are new to the museum's collections and some undoubtedly new to science.

Dr. F. W. Pennell, associate curator of the New York Botanical Garden, is engaged in collecting in the Rocky Mountain region of Colorado, the Wahsatch Mountains of Utah and the Yellowstone National Park. The object of the trip is to study and collect plants of Scrophulariaceæ. *Pentstemon* and *Castilleja* are the principal genera to be found in this region. He also asks the cooperation of collectors throughout the country in respect to this family, as many critical problems can only be solved after the accumulation of ample material.

Dr. C. K. Schneider, of Vienna, who has recently been engaged in botanical exploration in western China, has been visiting the botanical institutions of the United States. Dr. Schneider is an authority on woody plants.

The schooner *George B. Cluett*, chartered by the Crocker Land relief expedition to go in quest of Donald B. MacMillan and the members of his party in Greenland, expected to sail from North Sydney, Nova Scotia, on July 10. Dr. Edmund Otis Hovey, of the American Musuem of Natural History, chairman of the Crocker Land Exploration Committee, is in charge.

On July 7, Professor C. J. Keyser, of Columbia University, delivered an address on "The Human Worth of Rigorous Thinking," before the mathematics section of the California High School Teachers' Association, at the University of California. On the evening of July 12 he presented a paper on science and religion before the Chit-Chat Club of San Francisco at a meeting held at the University Club of San Francisco.

Sir William Ramsay gave the address on July 1 at the annual meeting of the British Science Guild on "The National Organization of Science."

The annual general meeting of the Eugenics Education Society was held on July 1, when the presidential address was delivered by Major Leonard Darwin on the subject, "Eugenics during and after the War."

Dr. S. Alexander, professor of philosophy in the University of Manchester, has been appointed to the post of Gifford lecturer at the University of Glasgow for the period of 1916–1918.

Through the generosity of an anonymous donor, a lectureship has been established at the Mount Sinai Hospital named after the late Dr. Edward G. Janeway, who was for many years associated with the medical staff. The foundation has been created for the purpose of inviting important investigators to present the results of their work to the staff of the hospital.

The centenary of the birth of David Waldie, who suggested a trial of chloroform as an anesthetic to Sir James Simpson, has been commemorated by a bronze tablet, placed on the house in Linlithgow where he lived for some time. It has on it a portrait of Waldie, with an inscription in which he is described as a pioneer in anesthetic research.

In Science for July 9 the death was recorded of Professor Pieter Zeeman, of the University of Leiden. Unfortunately he was confused in this and other journals with Professor Pieter Zeeman, of the University of Amsterdam, the well-known discoverer of the magnetic resolution of spectral lines. Physicists will regret the loss of the distinguished professor of theoretical and geometrical mechanics in the University of Leiden, but will be glad to know that work of such fundamental importance as that done in the Amsterdam laboratory on the spectrum is not to be interrupted by the untimely death of its author.

Professor Frederick Prime, who held the chair of natural history in Girard College, Philadelphia, and had previously been professor of geology and metallurgy in Lafayette College, one of the secretaries of the American Philosophical Society, has died at the age of seventy years.

MRS. W. W. MAYO, aged ninety years, wife of the late Dr. W. W. Mayo, founder of the Mayo Clinic and Surgical Institute, Rochester, Minn., and mother of the distinguished surgeons, Dr. W. J. Mayo and Dr. C. H. Mayo, has died.

MR. HOWARD MARSH, master of Downing College, and professor of surgery in the University of Cambridge, died on June 24, aged seventy-five years.

DR. R. H. LOCK, inspector at the British Board of Agriculture and Fisheries, sometime fellow of Gonville and Caius College, Cambridge, died on June 26, at thirty-six years of age.

DR. G. C. M. MATHISON, known for his work on the physiology of respiration, and Lieutenant R. B. Woosnam, who has conducted zoological explorations, have been killed at the Dardanelles.

JOSEPH FARRIGAN, prominent mining engineer and entomologist, died at his home in St. Louis, on May 9, at the age of fifty-eight years. He was an authority on the aphididæ and a coworker with C. V. Riley, in the later seventies.

MR. F. H. NEVILLE, F.R.S., fellow of Sidney Sussex College, Cambridge, distinguished for his contributions to metallurgy, has died at the age of sixty-eight years.

CAPTAIN J. W. JENKINSON, late fellow of Exeter College, Oxford, and university lecturer in embryology, was killed on June 4 in the trenches in Gallipoli. He was forty-three years of age.

DR. CHAILLON, head of the anti-rabies department of the Pasteur Institute, having demanded and obtained the perilous mission of disinfecting a battlefield near the enemy's trenches, was killed in fulfilling this service.

DR. ALEXANDER R. CRAIG, of Chicago, secretary of the American Medical Association, reports that its membership has increased from 74,235 in 1914 to 76,020 in 1915.

THE twenty-second summer meeting of the American Mathematical Society will be held at the University of California and Stanford University, Tuesday to Thursday, August 3-5. Tuesday morning will be devoted to a joint session with the American Astronomical Society and Section A of the American Association for the Advancement of Science. Separate sessions of the Mathematical Society will be held on Tuesday afternoon and on Thursday at Berkeley and on Wednesday at Stanford University.

THE mid-summer field meet of the American Fern Society was held at Jamesville, N. Y. Members and their friends assembled on Tuesday evening, July 13, at the home of Mr. Wm. Spalding, 405 Comstock Ave., Syracuse, N. Y. Excursions were arranged under the guidance of Dr. Benedict, Dr. Todd and Mrs. H. E. Ronsier on days following.

THE preliminary list of awards by the Panama-Pacific International Exposition gives the Department of the Interior collective exhibit one grand prize. The exhibit of the Geological Survey receives one grand prize, four medals of honor, five gold medals, six silver medals, and two bronze medals. The Bureau of Mines receives one grand prize, six medals of honor, three gold medals, and three silver medals.

CONSTITUTIONALITY of the Illinois pure food law prohibiting in effect sale of a food preservative containing boric acid was upheld on June 21 by the Supreme Court. Justice Hughes, for the court, held that validity of the law must be upheld unless the defendant showed there was no doubt about boric acid being wholesome. The court held he had failed to do so.

A CIRCULAR has been issued by Dr. J. B. de Lacerda, the director of the National Museum in Rio de Janeiro, calling attention to the fact that on June 7, the collection of mineralogy in that institution was robbed of a green aquamarine weighing 11 kilos and 800 grams, two topazes, and a number of small diamonds. Dr. Lacerda requests mineralogists and directors of museums in North America to communicate instantly with him by telegraph, at his expense, in case these objects are offered for sale, and authorizes those to whom they

may be offered to take such steps as may be necessary to secure the return of the stolen property to the National Museum of Brazil.

THE *American Museum Journal* states that through interest created by the Roosevelt South American expedition, the Museum has received six hundred birds and fifty mammals, presented by the Goeldi Museum of Pará, through its director of zoology, Dr. Emilie Snethlage. The members of the North American expedition when passing through Pará in May, 1914, called on Dr. Snethlage to examine the rich collections of Amazonian fauna which she, and her predecessor Doctor Goeldi, have amassed. Dr. Snethlage writes that shortly after the Roosevelt party passed through Pará she herself embarked on an expedition into the unexplored portions of the Upper Xingú, on which she was absent seven months.

PREPARATIONS for an enrollment of a hundred students at the summer session of the Puget Sound Marine Station have been made by Dr. Theodore C. Frye, acting dean of the college of science and director of the biological plant at Friday Harbor. Dr. Frye recently returned from the station, having spent several days there arranging for the season's work. Last year there were 43 students, practically all of whom were college graduates, doing research work. This year parties are expected from educational institutions in Illinois, Minnesota, Kansas, Nebraska and Utah. An improved water supply is afforded the station this year. Heretofore deep wells have furnished the water, which was not, however, good for experimental purposes. Friday Harbor now gets its supply from Echo Lake, and mineral content will no longer be a handicap. A new gravel road from the station to the town of Friday Harbor is another convenience completed this year. The shrimp steamer *Violet*, which was chartered last year, will again dredge for laboratory material, which abounds at the bottom of the harbor at a depth of about 100 fathoms.

THE Lake Laboratory of the Ohio State University at Cedar Point, is this year under the direction of Professor Herbert Osborn, head of the department of zoology. Edward L. Fullmer, M.Sc., of Baldwin Wallace College at Berea, Ohio, will supervise the work in botany. Professor Frederick H. Krecker, of the department of zoology of the Ohio State University, and Professor S. R. Williams, of Miami University, will have charge of the work in zoology. Charles G. Shatzer, M.A., of Wittenberg College, will teach the classes on birds. The laboratory is situated on the shore of Sandusky Bay, where students have access to marshes, river, forests, sandy beaches and rocky islands. At Put-in-Bay is the United States fish hatchery, and glacial groves are at Kelly's Island.

ON June 18, 1915, the Board of Estimate and Apportionment of New York City passed a resolution authorizing the issue of $100,000 corporate stock of the City of New York to provide means for permanent improvements at the Brooklyn Botanic Garden, including the completion of the laboratory building and plant houses. This action was taken following the generous offer of Mr. Alfred T. White, chairman of the Botanic Garden Committee of the Brooklyn Institute trustees, to secure a like sum by private subscription. The amount was subscribed by Mr. White, and the donors of the original endowment of the garden. Plans are now being prepared for the completion of the buildings, only one fifth of which are now erected. It is expected that ground will be broken this coming fall.

Nature calls attention to the forthcoming sale of Stonehenge by auction. The property is under the protection of the Ancient Monuments Act, which ensures its preservation; and the auctioneers, Messrs. Knight, Frank and Rutley, 20 Hanover Square, W., announce that Sir Cosmo Antrobus, who is only tenant for life, proposes, if his powers permit him to do so, to impose conditions providing for the public having access thereto for all time. It is hoped, however, that Stonehenge may be bought either by the government or by a learned society, and if any reasonable proposal be made for its acquisition with the intention of preserving the monument in the public interest, the auctioneers are instructed to facilitate a sale by private treaty before the auction.

ENGLISH journalists state that the British Institute of Industry and Science, acting in cooperation with the British Empire Exhibition Association, is promoting on a wide scale an exhibition of the national resources of the empire, which will be opened at the beginning of next year in a handsome building to be erected on the Aldwych site, where the existing offices of the institute are situated. The purpose of the exhibition is to demonstrate to the public, as well as to manufacturers and industrialists, the potentialities of the empire as contained in its natural resources. The various dominions and colonies are cooperating in the scheme, and each colony will, with the advice of the central body, organize its own particular section of the exhibition. The cost of the project will be about £50,000, which has been provided for through the generosity of the directors of the institute. The exhibition will, it is expected, remain open during the whole of next year.

UNIVERSITY AND EDUCATIONAL NEWS

THE Medical College of the University of Cincinnati has received several large donations during the past month. Mrs. Mary M. Emery promised the university the sum of $250,000 for a new Medical College Building, on the condition that an additional $250,000 be raised by July 1 for its equipment and maintenance. At the appointed time, Dean C. R. Holmes, of the College of Medicine, announced that $250,000 had been secured. The new structure will be located on grounds adjacent to those of the Cincinnati General Hospital, which occupies 24 buildings and covers 27 acres, and which offers unusual opportunities for clinical instruction. The sum of $30,000 has just been raised by citizens of Cincinnati for the purpose of maintaining for three years a chair of medicine in the Medical College. The chair will be known as the Frederick Forchheimer chair of medicine, in honor of the late Dr. Frederick Forchheimer, who was for years professor of medicine at the Medical College. Dr. Robert S. Morris, lately of Clifton Springs, New York, and formerly of Ann Arbor and of Johns Hopkins University, has been appointed to the new position.

ON June 8, during the commencement week at De Pauw University, the corner stone of the new Bowman Memorial Gymnasium was laid with appropriate ceremonies. The building will cost over $100,000.

THE new Honan Biological Institute at University College, Cork, has been completed, as we learn from the *British Medical Journal*, owing to the generosity of the trustees of the estate of the late Miss Honan, and forms a handsome group of buildings, situated near the plant houses which were the gift of the late William Crawford, of Lakelands. The biological laboratory was a small building, much too cramped for the teaching of the students, much less for the research work which has always been a feature of the college. In the new building ample room has been provided for the study of zoology, botany and geology. There are junior and senior zoological and botanical laboratories, as well as research rooms, geological and geographical laboratories, and a large semicircular lecture theater, lit from the roof, and capable of accommodating about 100 students.

THE summer session of the University of California for 1915 by June 30, nine days after the beginning of the six-weeks term, had enrolled 5,420 students, which was more than 2,000 more than on a corresponding date the year before and which was only 52 less than the largest total registration at any one time in the academic colleges and graduate school for the fall or spring sessions excluding students in the professional colleges.

AMONG instructors appointed at the Massachusetts Institute of Technology are: Barnum B. Libby and George Rutledge, mathematics; Walter A. Patrick, theoretical chemistry; Clark S. Robinson and Frederic H. Smyth, inorganic chemistry. Promotions include: Robert P. Bigelow, associate professor of zoology and parasitology; W. Felton Brown, associate professor of freehand drawing; Harold A. Everett, associate professor of naval architecture; Henry B. Phillips, assistant professor of mathematics; Kenneth C. Robinson and Geo. H. Clark, instructors in mechanical engineering; John E. Bird, instructor in mechanical

drawing and descriptive geometry; Leicester F. Hamilton, instructor in analytical chemistry, and Ruth M. Thomas, research associate in organic chemistry.

Dr. Ward J. MacNeal has been appointed director of laboratories of the New York Post-graduate Medical School and Hospital, succeeding Dr. Jonathan Wright, resigned. Dr. Morris Fine has been promoted to adjunct professor of pathologic chemistry; Dr. Richard M. Taylor, to adjunct professor of pathology and Paul A. Schule, to a lectureship of bacteriology.

Mr. R. H. Bogue, for three years instructor in chemistry in the Massachusetts Agricultural College, has accepted a position as assistant professor of agricultural chemistry at the Montana Agricultural College. His place in the Massachusetts College has been filled by the appointment of Paul Serex.

Dr. F. D. Fromme, formerly of the botany department of the Indiana Agricultural Experiment Station, has been appointed to the professorship of plant pathology and bacteriology in the Virginia Polytechnic Institute.

Guy West Wilson, formerly agent, U. S. Laboratory of Forest Pathology, stationed at the Agricultural Experiment Station, New Brunswick, N. J., has been appointed assistant professor of mycology and plant pathology, State University of Iowa, Iowa City, Iowa.

DISCUSSION AND CORRESPONDENCE

NOTE ON THE MERIDIONAL DEVIATION OF A FALLING BODY

Introductory Remarks.—Various definitions have been given for the meridional deviation of a falling body and various potential functions have been assumed in the mathematical determination thereof. It is therefore perfectly natural that the results found by different writers on the subject do not agree. However, when once the equations of motion of the falling body, the definition of the deviation, and the potential function have been fixed, the solution of the problem is unique. In 1911[1] I published a general formula for the meridional deviation which included as special cases the apparently discordant formulæ of several other writers. This was possible because my formula could be broken up into parts which corresponded to different kinds of meridional deviation, and also because it was expressed in terms of the symbol representing the potential function, which symbol, when replaced by particular forms of this function, made it yield the results of the writers who had used these particular forms. In 1913[2] Dr. R. S. Woodward treated the problem using the equations of motion, the definition of the deviation and one of the potential functions which I had used. Therefore he should have obtained the result which I did for that potential function provided my solution was correct. But he got a different result. This lack of agreement was the means of interesting Professor F. R. Moulton in the problem. In June, 1914, Professor Moulton published an article[3] in which he solved the problem treated by Dr. Woodward and his result was the same as mine. Shortly after the appearance of Professor Moulton's article, I published a paper[4] (which, however, was prepared at the same time as Professor Moulton's, and independently of it) showing that Dr. Woodward's methods, when applied to his initial assumptions, should lead to my results. In reply to Professor Moulton's article and my last paper, Dr. Woodward has just published a note[5] in which he states that he did not solve the problem which Professor Moulton and I had solved. The present article is my reply to this note.

Granting that "two different problems have actually been solved," I will show that this is so because Dr. Woodward has not solved the

1 *Transactions of the American Mathematical Society*, Vol. XII., pp. 335–53, *ibid.*, Vol. XIII., pp. 469–90.

2 *Astronomical Journal* (Nos. 651–52), August 4, 1913.

3 "The Deviations of Falling Bodies," *Annals of Mathematics* (Second Series), Vol. 15, pp. 184–94, June, 1914.

4 "Deviations of Falling Bodies," *Astronomical Journal*, Nos. 670–72, pp. 177–201, January 22, 1915.

5 "Note on the Orbits of Freely Falling Bodies," Science, New Series, Vol. XLI., No. 1057, pp. 492–95, April 2, 1915.

problem which he originally proposed. The solution of the problem which he now states in his note that he has solved corresponds to a meridional deviation different from that originally defined. This deviation is of the form $Ah + Bh^2$, while that originally defined was of the form Ch^2, in which h is the height of fall and A, B, C are constants. I will also show that a formula for this new meridional deviation may be obtained without integrating the equations of motion at all, and that this formula yields a result differing but slightly from the result given by Dr. Woodward, but given by him for the deviation originally defined. In this article I will also reply to certain criticisms made by Dr. Woodward concerning my work.

1. In the sixth paragraph of his note[6] Dr. Woodward says:

> Now, to account for the discrepancy in question, namely, our differing values for the meridional deviation of the falling body, it is only essential to observe that two different surfaces of reference have been used. Professors Moulton and Roever have referred the motion to a geoid specified by a certain approximate potential function, while I have referred the same motion to Clarke's spheroid of revolution (of 1866), which is determined by certain axes (a, b) dependent on geodetic measurements.

In reply to this statement I should like to say that in order to determine the path (orbit) of the falling body a potential function is needed; a surface of reference is not enough. When once the potential function is chosen the geoid (or level surface) is determined. That the geoid, and not the spheroid, was originally contemplated by Dr. Woodward as the surface of reference, appears from the statement made below equations (2) of his paper in the *Astronomical Journal* (Nos. 651–52). For, of the points P_0 and P_1 from which, respectively, the body is let fall and the deviations measured, he says:

> *It is important to specify how this point P_1 is located with reference to the initial point P_0. Imagine a basin of mercury at the point P_1. The surface of the mercury will be the level, or equipotential (or horizontal) surface through this point; and if it is located as here assumed the line joining the two points P_0 and P_1 will be normal to the surface of the mercury.*

Now, the surface of the mercury is surely a portion of the geoid and *not* of the spheroid. The position of the point P_1 besides depending on that of P_0, depends on the potential function, and, furthermore, on the same potential function as that which is used in the differ-

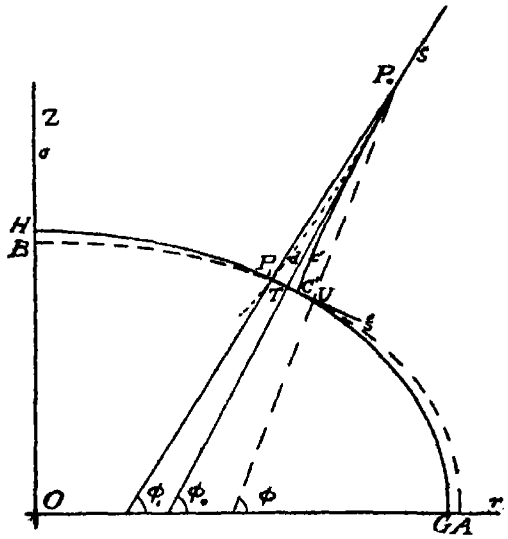


FIG. 1.

ential equations of motion of the path of the falling body. Dr. Woodward now states that he used for his surface of reference the spheroid (of Clarke) instead of the geoid. If these two surfaces differ ever so slightly from one another—and they do differ according to equations (2) and (3) of his note[7]—the quantities which are determined by using the spheroid for reference are not the same as the quantities η, ξ (measured from P_1) which he originally defined as the easterly and meridional deviations of the falling body. Therefore, the problem which he now states that he has solved is not the one which he originally proposed.

[6] SCIENCE, No. 1057, pp. 493.

[7] SCIENCE, No. 1057.

2. For the sake of simplicity let us assume (as Dr. Woodward did before he got very far into his solution) that the distribution of the earth's gravitating matter is such as to make the potential function independent of the longitude (*i. e.*, correspond to a *distribution of revolution*). Let P_0 denote the point (fixed with respect to the earth) from which the body falls. In Fig. 1 the plane of the drawing is assumed to be the meridian plane of P_0. This plane contains the axis of rotation OZ, and cuts from the geoid and the spheroid (both of which are surfaces of revolution of axis OZ) the meridian curves GH and AB, respectively, GH drawn full and AB dashed. The point P_1 is the foot of the perpendicular from P_0 to the geoid GH. The straight line P_1P_0 is then the vertical of PA and the angle ϕ, which it makes with the equatorial plane (perpendicular to the axis OZ) is the astronomic latitude of P_1. The straight line P_0T (not coincident with P_0P_1) is the vertical of P_0 (*i. e.*, the normal at P_0 of the level surface through P_0). The angle ϕ_0 which it makes with the equatorial plane is the astronomic latitude of P_0.[8] The path (with respect to the earth) of the falling body is a curve c which does not lie in the meridian plane of P_0, but is tangent at P_0 to the vertical P_0T of P_0. This curve c pierces the horizontal plane of P_1 (*i. e.*, the plane through P_1 perpendicular to P_1P_0) in a point C. Let us denote by c' and C' the orthographic projections of c and C, respectively, on the meridian plane of P_0. Then c' is also tangent to P_0T at P_0. According to the definitions originally adopted by Dr. Woodward,

$C'C$ is the easterly deviation of the falling body,
P_1C' is the meridional deviation of the falling body.

He now says, however, that he referred the motion of the falling body to the spheroid (AB, Fig. 1). By this he must mean that he measures the deviation of the falling body from the foot U of the normal drawn from P_0 to the spheroid. The angle ϕ which this normal (shown in Fig. 1 by the dashed line P_0U) makes with the equatorial plane is called the geodetic latitude of U. In other words, the statement that the spheroid is his surface of reference implies that UC' is the meridional deviation of the falling body. That this is the implication is also borne out by the fact that the value of this deviation agrees with the value which Dr. Woodward actually found. In order to show this let us first observe that

(1) $$UC' = UT + TC',$$

the positive sense of each of these quantities being taken toward the equator. If ϕ and ϕ_0 be expressed in radians,

(2) $$UT = (\phi_0 - \phi)h,$$

where $h = P_1P_0$ is the height of fall. Since the curve c' is tangent to P_0T at P_0, and has no cusp there,[9]

(3) $$TC' = \tfrac{1}{2}(1/\rho_0)h^2 + \text{higher powers of } h,$$[10]

where ρ_0 is the radius of curvature of c' at P_0. By equations (2) and (3) of Dr. Woodward's note,[11] $\phi - \phi_0 = 12'' \sin 2\phi$, and hence in circular measure

(4) $$\phi - \phi_0 = .00006 \sin 2\phi.$$

Hence for the data

(5) $$h = 49024 \text{ cm.}, \phi = 45°,$$

assumed in his example in the *Astronomical Journal* (Nos. 651–652)

$$UT = -2.94 \text{ cm.}$$

[8] The difference between ϕ_0 and ϕ_1 is given by the formula

$$\phi_0 - \phi_1 = \frac{-(\partial g/\partial \xi)_1}{g_1} h + \text{higher powers in } h,$$

where h is the distance of P_0 above P_1, g_1 is the value of the acceleration due to weight at P_1, and $(\partial g/\partial \xi)_1$ is the value, at P_1, of the derivative of g with respect to ξ, where ξ represents distance measured to the south at P_1. For the potential function used by Dr. Woodward (*Astronomical Journal*, Nos. 651–52),

$$\frac{-(\partial g/\partial \xi)_1}{g_1} = 8.3 \times 10^{-13} \sin 2\phi_1.$$

[9] The curve c has a cusp at P_0 as has also its projection on a plane perpendicular to the meridian plane of P_0.

[10] See "Introduction to Infinite Series," by Osgood, p. 39.

[11] SCIENCE, No. 1057.

For the same data and for the potential function used by Dr. Woodward,[12]

$$TC' = .0010 \text{ cm.}$$

Therefore

$$UC' = UT + TC' = -2.94.$$

This result agrees very well with the value $\xi = -3.03$ obtained by Dr. Woodward for his originally defined meridional deviation. Thus I have shown that for the meridional deviation implied by the statement that the spheroid instead of the geoid is the surface of reference, it is possible to find a formula, namely

$$(6) \qquad UC' = -(\phi - \phi_0) \sin 2\phi \cdot h,$$

without integrating the equations of motion, and that, for the data given by equations (2) and (3) of Dr. Woodward's note, this formula yields values for the deviation UC' which do not differ much from those obtained by Dr. Woodward for his originally defined meridional deviation.

3. We have just seen that the expression (formula 6) for the newly defined meridional deviation UC' begins with the first power of h. Let us now show, with the aid of Fig. 1, that the originally defined meridional deviation P_1C' begins with the second power of h. For this purpose let us think of a series of level surfaces between the geoid GH and the level surface of P_0. The locus of the feet of the perpendiculars from P_0 to these level surfaces is a curve d passing, necessarily, through the points P_0 and P_1 and tangent at P_0 to the vertical P_0T of P_0 (see dotted curve in Fig. 1). Since the curve d is tangent to P_0T at P_0, we have for a reason given above,

$$(7) \qquad P_1T = \tfrac{1}{2}(1/\rho_d)h^2 + \text{higher powers of } h,$$

where ρ_d is the radius of curvature of the curve d at the point P_0. It is further evident from Fig. 1, that

$$(8) \qquad P_1C' = P_1T + TC',$$

the positive sense of each of these quantities being taken toward the equator. By relations (3), (7) and (8)

$$(9) \qquad P_1C' = \frac{1}{2}\left(\frac{1}{\rho_d} + \frac{1}{\rho_0}\right)h^2 + \text{higher powers of } h.$$[13]

Hence we see that while the originally defined meridional deviation P_1C' begins with the second power of h, the newly, implicitly, defined meridional deviation UC' begins with the first power of h.

4. In commenting on my work, Dr. Woodward, after speaking of a certain assumption,

[12] The quantity TC' is the negative of the quantity which I denoted by η_1 in my first paper (*Transactions of the American Mathematical Society*, Vol. XII., No. 3, pp. 335–53). It is the quantity which Comte De Sparre used for his meridional deviation of a falling body. I have shown this quantity to be expressible by the formula

$$TC' = \left\{2\omega^2 \sin 2\phi_0 + \left(\frac{\partial g}{\partial \xi}\right)_0\right\}\frac{h^2}{6g_0},$$

where h and ϕ_0 have the meanings given above, ω is the angular velocity of the earth's rotation, and g_0 and $(\partial g/\partial \xi)_0$, are the values which the acceleration g due to weight and the derivative of g with respect to ξ have at the point P_0, ξ representing distance measured to the south. For the potential function used by Dr. Woodward (*Astronomical Journal*, Nos. 651–52), $(\partial g/\partial \xi)_0 = -8.14 \times 10^{-6} \sin 2\phi_0$ and hence, since $\omega^2 = 5.3173 \times 10^{-9}$ we have for this potential function

$$TC' = 2.49 \times 10^{-9} \sin 2\phi_0 \cdot \frac{h^2}{6g_0},$$

which for the data (5) yields

$$TC' = +.0010 \text{ cm.}$$

[13] It is not difficult to show that

$$P_1T = -\left(\frac{\partial g}{\partial \xi}\right)_0 \cdot \frac{h^2}{g_0},$$

where the terms have the same meaning as in the preceding foot-note. Consequently

$$P_1C' = P_1T + TC' = \left\{2\omega^2 \sin 2\phi_0 - 5\left(\frac{\partial g}{\partial \xi}\right)_0\right\}\cdot\frac{h^2}{6g_0}.$$

This formula I proved for the first time in the *Transactions of the American Mathematical Society*, Vol. XII., No. 3, pp. 335–53. See also Vol. XIII., pp. 469–90, *Astronomical Journal*, Nos. 670–72 and *Bulletin of the American Mathematical Society*, 2d series, Vol. XXI., No. 9, pp. 444–62. For the potential function used by Dr. Woodward,

$$(\partial g/\partial \xi)_0 = -8.14 \times 10^{-6} \sin 2\phi_0,$$

whence, for that potential function

$$P_1C' = 51.33 \times 10^{-6} \sin 2\phi_0 \; h^2/6g_0,$$

which for the data (5) gives

$$P_1C' = +.021 \text{ cm.}$$

now abandoned, which he made concerning my earlier paper, says:

> This assumption was supported by uncertainty as to meaning and by lack of homogeneity of his expression for the potential function introduced on page 342 of his first paper; and still more by his identification of astronomic with geocentric latitude (on p. 339, same paper) by means of the loose phrase "with sufficient approximation." A similar lack of "accuracy and precision" will be found in several parts of his latest paper cited above. See, for example, his equations (j), wherein he confounds geocentric with reduced latitude; also p. 199, where he identifies his equations (38) and (41) with my equation (26) and makes with respect to them the surprising statement, "it is, of course, evident that this function corresponds to some distribution of revolution" in the earth's mass.

I shall reply first to the criticism concerning the "identification of astronomic with geocentric latitude." After having derived (in my first paper) a general formula for the meridional deviation of a falling body, I assigned various particular forms to the potential function and thus obtained the formulæ for the meridional deviations corresponding to these particular potential functions. Some of these potential functions were expressed in terms of astronomic latitude, and others in terms of geocentric. Consequently, the same thing was true of the corresponding formulæ for the meridional deviation. For instance, the formula of Gauss was expressed in terms of astronomic latitude and several others were expressed in terms of geocentric latitude. In order to compare the magnitudes given by the special formulæ I replaced, in the formula of Gauss, the symbol representing astronomic latitude by that representing geocentric, and in so doing I used the expression "with sufficient approximation" for which I am now criticized. It is of course evident that by this procedure a slight error was made in the formula of Gauss *after* its rigorous form had been derived. But none of the other work was thereby affected, the derivation of the general formula as well as that of each of the special formulæ being strictly rigorous. Concerning the criticism about my equations (j) I wish to say that the parameter ψ may be regarded as a geocentric latitude, since it is measured at the center of the spheroid and from the equatorial plane. I did not say that it was the geocentric latitude of the point (τ, σ). However, it would have been well to mention that it is called the reduced latitude of the point (τ, σ). But even if the reader interprets it as the geocentric latitude of the point (τ, σ), the argument in which it is used will not thereby be vitiated. For, as I pointed out, the relation (l) in which it is used is approximate, the relation (n) being the exact relation approximated. Now, the error made in using relation (l) instead of relation (n) is twice as great as the error made in relation (l) by calling ψ the geocentric instead of the reduced latitude of the point (τ, σ). As regards the "surprising statement," I should like to point out that on page 192[14] I defined a distribution of revolution as one for which $\partial V/\partial\lambda = 0$, and surely my function (38) satisfies this condition since it does not contain the longitude λ. Then I was very particular to say—in the last foot-note on page 199—that for the assumption $B = A$ made by Dr. Woodward in his relations (31), his potential function (26) is the same as my potential function (38). Concerning the potential function introduced on page 342 of my first paper, I stated that it had been taken from Poincaré, "Figures d'Equilibre d'une Masse Fluide" (1902), Chapt. V. Following Poincaré, I used the symbol M where Dr. Woodward used the symbol $M\kappa$. In other words, I suppressed the gravitation constant. But it was easy to see from the expressions and values of the constants that no error had been made in so doing.

WM. H. ROEVER
WASHINGTON UNIVERSITY,
ST. LOUIS

VEGETATIVE REGENERATION OF ALFALFA

WHEN growing alfalfa plants in the greenhouse, for infection experiments with the crown-gall of alfalfa (*Urophlyctis alfalfæ*), the writer found it desirable to clip the shoots at intervals in order to secure a multiplication of the adventitious buds from the crown.

[14] *Astronomical Journal*, Nos. 670–72.

Some of the portions of the leaves and stems clipped from the plants dropped upon the soil of the pots and were allowed to remain there. Some days later it was found that a number of these fragments had put out roots from the cut surfaces and were developing into healthy shoots. As the plant under consideration is of great economic importance, a further experiment was tried in order to see if the regeneration of shoots from cut fragments of alfalfa is easily induced. A handful of fragments cut from an entirely different group of alfalfa plants was scattered loosely over the surface of a pot of well-watered soil. The fragments were watered from day to day, care being taken to avoid altering their positions. After a week it was found that fragments of several descriptions had rooted firmly and were developing into healthy shoots. The regenerating fragments included portions of stems, portions of petioles, petioles with blades attached, leaflets without petioles attached, and even small portions of the leaf blade.

So far as the writer has been able to learn, multiplication by this vegetative method has not been reported of alfalfa previous to this time. Under favorable conditions, such regeneration might assume considerable importance in the field. Especially suggestive is the possibility of strengthening a stand in an irrigated district by an early cutting followed by free watering. The cut portions might be left where they fall, or collected and scattered over areas where the stand is thin.

ORVILLE T. WILSON
UNIVERSITY OF WISCONSIN

QUOTATIONS

THE ORGANIZATION OF SCIENCE IN GREAT BRITAIN

AT last, on all sides, it is being recognized that we should organize our scientific resources. Had the suggestion which I made to this effect on January 20 been acted on—that is to say, if the Royal Society had grouped the whole body of its fellows (mainly according to subjects) in grand committees and set these to work—we should have been many months in advance of our present position, and not a little might have been done to apply science to the numerous problems which are only now being hinted at in public. In view of our scientific conservatism, it is impossible to blame the uninstructed masses and difficult to find much fault even with our rulers.

It is well known that the men who are versed in the chemistry and properties of explosive materials and who might, during all these months, have rendered the greatest service in perfecting their production and in improving them have not been consulted. One of the two men to whom the service ammunition of all the armies of to-day is due is still with us and an active scientific worker; in no other country would it have been possible that such a man should not have been called into consultation. Many of us might have been of assistance if only as foremen in works—technical foremen have been badly needed.

It is imperative that the strongest body of technical opinion that we can bring together should be behind the War Office and the authority that is charged with the supply of explosives. It is to be hoped that Mr. Lloyd George is now alive to this need and of the deadly peril in which we stand if it be neglected. The suggestion has been made that Lord Haldane should be invited to preside over a committee of concentrated scientific intellect to deal with war problems. But Lord Haldane, as a lawyer, would be entirely out of place as chairman of such a body; it must be in expert hands to be of service. The government is not competent to select the members of such a commission. I believe the Royal Society to be the only competent advisory body under the circumstances—it is our scientific House of Peers, and if it can not either itself furnish sufficient competent men or provide them from the junior ranks of science, the sooner it is declared defunct the better.

I would again urge that the society be organized forthwith as a whole; not only is this the only way of eliminating personal differences, but it is the only way of getting at the ideas latent in our scientific community. No half-dozen or so persons, at the present time, have the right to assume that they can do all that is required in any branch of science; no

small number have the right to push their colleagues aside and say we alone will serve the country.

Mr. Wells asks for inventions; but inventions are only made by those who are aware of the requirements; it is often possible to devise a means to an end when the end is known; but those who might be of use are kept in the dark, very many of us are not allowed to know and to help. Professor Fleming has stated his experience, in the all-important letter which you have published; his authority on matters of wireless telegraphy and electrical engineering generally is indeed properly described, in Lord Curzon's words, as "high, not only in the estimation of this country, but in that of the whole world." I am in the same position as he is. Though I have fifty years' experience as a chemist, particularly in connection with the materials now being used in the manufacture of explosives and of natural and artificial organic products, I have never once been consulted; the only request for my assistance that I have received, since the outbreak of the war, came from a German gentleman long naturalized as a British subject. No doubt, I am properly regarded as merely a retired professor, but I know highly competent younger men among those trained by me who are equally unutilized.

Sir Joseph Larmor pointed out in your issue of March 29 that the country has no use for chemists. Yet we read daily in the papers that the chemist is now the people's darling in Germany, and that the war is a war of chemists; we know that it will be in industry when fighting is over. But in a country which is dominated by the lawyer-politician, in which, to use Matthew Arnold's expression, "the idea of science" is unknown, it can not well be otherwise. We shall continue to muddle along until, having reformed Oxford, we have changed our schoolmasters and the idea of science is abroad; it is perhaps fortunate that it is fast being hammered into us by high explosive shell.

As a fellow of all but forty years' standing, let me say in conclusion that, in my opinion, unless the Royal Society be organized as a whole forthwith in the service of the state, as well as provided with an efficient active executive in full sympathy with the situation, we shall deservedly sink into insignificance, because the peers of science will have shown themselves to be collectively impotent and without due sense of their public responsibilities.—*Henry E. Armstrong, in the London Times.*

SCIENTIFIC BOOKS

Modern Instruments and Methods of Calculation. A hand-book of the Napier Tercentenary Exhibition. Edited by E. M. Horsburgh, with the cooperation of others. The Macmillan Company, New York, 1914. Pp. viii + 344. Price $1.90 net.

It is very seldom that an international congress or a celebration on the occasion of any kind of academic anniversary offers the opportunity for the publication of anything more elaborate than a volume of memoirs. Such volumes are generally well worth the effort, but there is rarely anything unique in the plan, and the publications often serve as a tomb in which various worthy articles are consigned to oblivion. The Napier Tercentenary, however, offered an opportunity for something radically different in the way of memorial volumes. To be sure there is the collection of essays, soon to appear; but the committee in charge of the work hit upon the idea of an exhibition of all sorts of tables and calculating machines, and fortunately found a man well trained in the field of calculation, sympathetic with the historical development of the subject, and skilful in setting forth the description of material, and to this man they entrusted the task of preparing a volume that is quite unique in the history of such congresses.

Mr. Horsburgh had in charge the arrangement of the interesting exhibition in the university, and to some extent this work is a catalogue of the material displayed at that time. It is much more than this, however, since it includes a series of valuable essays describing the tables, the calculating machines of various types, and those instruments which, together with models and other material, enter into the equipment of a modern mathematical laboratory.

Among the special essays may be mentioned the following: "Napier and the Invention of Logarithms," by Professor Gibson, of Glasgow, perhaps the best essay which has appeared upon the great Scotch mathematician; "Notes on the Special Development of Calculating Ability," by Dr. W. G. Smith, an excellent summary of the history and psychology of the subject; "Calculating Machines," by F. J. W. Whipple, a description of the standard engines of calculation written from the standpoint of the practical computer and elaborating the descriptive catalogue prepared for the Fifth International Congress of Mathematicians in 1912; "The Calculating Machine of the East: the Abacus," by Dr. C. G. Knott, the efficient secretary of the Royal Society of Edinburgh, and one of the prime movers in the Napier Celebration—a classical essay upon the subject and one which has been out of print for nearly thirty years; "The Slide Rule," by Dr. G. D. C. Stokes, a historical review of the various types of these instruments; "Integraphs," by Charles Tweedie; "Integrometers," "Planimeters" and "Harmonic Analysis," by Dr. G. A. Carse and Mr. J. Urquhart; "Integrating Machines in Naval Architecture," by A. M. Robb; "A Differentiating Machine," by Dr. J. Erskine Murray; "Tide-predicting Machines," by Edward Roberts; "A Mechanical Aid in Periodgram Work," "A Mathematical Description of Conics" and "The Instrumental Solution of Numerical Equations," by D. Gibb; "Ruled Papers," by E. M. Horsburgh; "Collinear-point Nomograms," by Professor D'Ocagne; "Mathematical Models," by Professor Crum Brown; and "Closed Linkages," by Colonel R. L. Hippisley. Besides these essays, numerous shorter notes appear, all of them written by experts in their fields.

A catalogue of the mathematical portraits in the collection of W. W. Rouse Ball, the well-known writer on the history of mathematics, will prove of value to all collectors.

It is impossible in the space at our disposal to speak in detail of any of the essays, several of them profusely illustrated and all of an authoritative nature. Suffice it to say that the book should be in every mathematical library and workshop as being the most valuable treatise of its kind that we have in English, and, indeed, about the only one in any language except such as is found in the articles in the German encyclopædia.

DAVID EUGENE SMITH
TEACHERS COLLEGE,
COLUMBIA UNIVERSITY

Die Elemente der Entwicklungslehre des Menschen und der Wirbeltiere. Anleitung und Repetitorium für Studierende und Aerzte. VON OSCAR HERTWIG. 5te Auflage. Jena, Gustav Fischer, 1915. Pp. x + 464. 416 figs.

This work, already well known through former editions, must be regarded as among the *opera minora* of its distinguished author. It is professedly a utilitarian text-book, and discussions not adapted to "comprehensive brief presentation, suitable for a text-book," have been omitted. For further information, Professor Hertwig appropriately refers the student to his "Lehrbuch," ninth edition, his "Allgemeine Biologie," fourth edition, and the imposing "Handbuch der Entwickelungsgeschichte der Wirbeltiere," which he edited and to which he contributed important chapters.

The fourth edition of the "Elements" was published in 1910 and the present volume, although reset throughout, contains only minor changes—chiefly such as are designed to make the book more useful to students of medicine. Except that Hochstetter's series of diagrams of the development of the vena cava inferior has been replaced by Kollmann's drawings of the same subject, all the figures in the last edition have been republished. To these are added sixteen others, eight of which show young human embryos and their adnexa, three illustrate cleft palate, two pertain to the vascular system, and the remaining three represent the *tunica vasculosa lentis*, the human branchial region and one of Keibel's models of the urogenital tract, respectively. None of the new figures is original, for Professor Hertwig is not of those who, on seeing a good drawing, make another much like it to be called their own. He prefers to present to the students a

wide selection of familiar figures, which have served, quite as much as the text which accompanied them, to advance the science of embryology.

Chapter 1 begins with the following interesting statement:

> In the seventeenth and eighteenth centuries, the most confused ideas of the nature of the process of animal development still prevailed. Influenced involuntarily by the religious dogmas of their time, the greatest anatomists and physiologists, with few exceptions, were of the opinion that the germ was merely a much reduced miniature of the later fully developed condition.

Was not the idea of preformation a direct result of observation and reflection upon natural phenomena, quite apart from "religious dogmas"? This indeed appears to be true, and the comment of a distinguished theologian upon Professor Hertwig's statement is as follows:

> Let the men of science assume the parentage of their own *homunculi!* I certainly know of no dogma that the germ was a miniature of the man that was to be, nor even a doctrine which could be understood or misunderstood in that sense.

Thus it appears that this introduction needs explanation or revision. The entire work might profitably be expanded at many points, notably so as to include some account of the development of the lymphatic system. But the title of the book disarms such criticism; the *elements* are admirably presented in a text which is simple, direct and substantial throughout.

FREDERIC T. LEWIS

SPECIAL ARTICLES

ELECTRICAL DENSITY AND ABSORPTION OF β-RAYS

THERE have been a number of attempts to relate the absorption coefficients of various bodies for the β-radiation to some physical properties of the absorbing substance. In 1895, Lenard determined the absorption coefficients for cathode rays of a number of bodies, and concluded that the absorption varied approximately as the density, though his values of μ/D differed by more than one hundred per cent. Similar results were obtained for the absorption of β-rays from radium and uranium by Strutt and by Rutherford.

The first to determine the absorption coefficient of a considerable number of elements for the β-rays was Crowther, in 1906.[1] Crowther found the ratio of the absorption coefficient to the density of the elements to increase with the atomic weight of the absorbing element, but apparently not according to any regular law. Crowther, however, plotted the ratio of the absorption coefficient to the density of 31 elements against their respective atomic weights, and obtained a number of points which he divided into groups having no apparent physical or chemical relationships, and showed that the elements in each of these groups could be joined by curves having some resemblance to one another.

It is the purpose of this paper to show that the absorption coefficient of the elements for β-rays is dependent rather upon the electrical density of the absorbing agent than upon its mass density.

It has been shown in a number of papers by the present writer how the electrical charges of the dissociated ions in an electrolytic solution may be calculated from their masses and their migration velocities in an electric field. Knowing these charges and the volume occupied by a gram-atom of an element in its solid state, we may calculate the electric density of the element by dividing its atomic charge by its atomic volume. It is the electric density calculated in this way which seems to be an important determining factor in the absorption of the β-radiation.

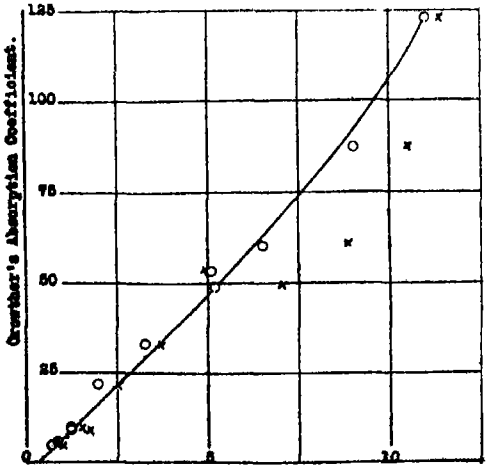
Unfortunately, only a small number of atoms have had their charges calculated in this way, but eleven of these are included in the list of thirty-one elements whose absorption coefficients for the β-rays of uranium were determined by Crowther.

In the table below column ii contains the values of λ/ρ for these eleven elements taken

[1] *Phil. Mag.*, 12, p. 379 (1906).

i	ii	iii	iv	v
Element	λ/ρ	λ	D_e	λ/D_e
Na..........	4.95	4.8	.66	7.28
Mg	5.1	8.9	1.25	7.12
K	6.53	5.7	.87	6.55
Ca..........	6.47	10.0	1.28	7.8
Cu..........	6.8	60.6	6.58	9.2
Zn..........	6.95	49.4	5.23	9.45
Sr..........	8.5	21.6	2.04	10.6
Ag	8.3	87.2	8.97	9.7
I	10.8	53.5	5.17	10.3
Ba..........	8.8	32.8	3.27	10.0
Pb..........	10.8	123.0	11.0	11.2

from Crowther's table, and in column iii are given the corresponding values of λ calculated by multiplying λ/ρ by the densities in the solid form of the corresponding elements. Column iv contains the electrical density, D_e, calculated by dividing the atomic charges of the elements by their respective atomic volumes in the solid state, and column v contains values λ/D_e. It will be seen that the variations from a mean value are less in column v than in column ii. This is also shown graphically in Fig. 1, where the mass densities and the electrical densities are plotted against the absorption coefficient. The points representing the relations of the electrical densities to the corresponding absorption coefficients are indicated by circles, while the corresponding points for mass densities are indicated by crosses. It will be seen that the circles lie more nearly on a smooth curve than do the crosses.



Electrical Density Indicated By Circles.
Mass " " " Crosses.

FIG. 1.

FERNARDO SANFORD
STANFORD UNIVERSITY, CALIF.

EVIDENCE PROVING THAT THE BELLY RIVER BEDS OF ALBERTA ARE EQUIVALENT WITH THE JUDITH RIVER BEDS OF MONTANA

ON the twenty-fourth of last July a paper of mine appeared in SCIENCE in which I took the ground that the Dog Creek Beds of Montana were equivalent to the Edmonton Beds of Alberta and that the Cow Island Beds of Montana should be correlated with the Belly River series of Alberta, with the Fort Pierre deposits between. I thus took the early views of Professor E. D. Cope that the Judith River Beds were on top of the Pierre. Judging from memory, I was unable to believe that the Fort Pierre was on top of the Judith River formation. I concluded, therefore, that the sequence of rocks in Montana would be the same as those in Alberta, where the Belly River series is below the Pierre, and the Edmonton is above.

Last July, however, with Mr. D. B. Dowling, a senior geologist of the Geological Survey of Canada, and my son, Charles M., who took most of the photographs, I spent ten days in the Judith River country, going over the same region I walked over in 1876 as Professor Cope's assistant. I was soon forced by incontestable evidence to change my opinions, and accept without reservations the conclusions of Hatcher and Stanton in their fine work on the "Geology and Paleontology of the Judith River Beds." We actually added to the weight of the evidence they had gathered by the discovery, as I believe for the first time, of some sixty feet of Bear Paw shales on top of the Judith River Beds, on the head of Taffy Creek, an easterly fork of Dog Creek. Also heavy masses on top on the south side of the river near Cow Island. Mr. R. G. McConnell, deputy minister and director of the Geological Survey of Canada, has kindly allowed me to present this paper in a private capacity, Mr. Dowling being the mouthpiece of the Geolog-

ical Survey of Canada on this exploration. It was seen how easily the early explorers could have misunderstood the arrangement of the strata, as they have been tilted in all directions and at all angles. In one place great masses of the rocks, often acres in extent, have been lifted higher than newer rocks, or dropped below them. Then the stratigraphical characters of the Claggett shales resemble those of the Pierre so closely it is difficult at first view to tell them apart.

Last July we followed up the valley of Dog Creek, on the road to a sheep ranch on the prairie. A couple of miles above where the creek enters the canyon we came to a strip of Claggett shales lifted up besides the Eagle Sandstone and Judith River Beds, the shale disintegrating into rather steep slopes over which our road lay. We climbed the steep ascent to the ridge, some 600 feet above the Missouri River and followed the divide between the Badlands of the Missouri and of Dog Creek. We camped on Taffy Creek, an eastern branch of Dog Creek. We made a very thorough study of this region, making large collections of invertebrates from all the horizons, and secured *Myledaphus* and sharks' teeth from the Eagle Sandstones, which, with the Claggett shales, I am informed, forms the base of the Belly River series of Canada.

On the south side of Taffy Creek below a large timbered Hog Back, I found a locality in the gray sandstone of the Judith River Beds that may possibly be the type locality from which we got collections on that memorable expedition in 1876, when we found the first horned dinosaurs of the United States, a "blow out" as it is called in the west, where quite an area in a bed of sandstone had been denuded, I found quantities of the teeth of horned, plated, duck-billed and carnivorous dinosaurs and of *Myledaphus bipartitus* Cope, scales of ganoid fishes, vertebræ of *Champsosaurus* and many fragments of turtle shells (*Trionx*, etc.), and what delighted me more, a complete footed ischium with most of the illium and pubis of one individual of a hooded trachodont, evidently Lambe's *Stephanosaurus marginatus*, from the Belly River series of Red Deer River, Alberta. It was difficult for me not to believe I was in a Red Deer bone-bed, as the same material was strewn around here in Montana. In the Edmonton, however, the bones have the appearance of having once been flotsam along a sea shore at the limit of high tide. I only found a couple of fragments of turtle shells there, while they are very abundant in this bone-bed on Taffy Creek. Everywhere in this region are two veins of coal, on top of the Judith River Beds and immediately below the Bear Paw shales. Above each vein is an oyster bed, often three or four feet thick. In the Bear Paw shales south of camp, with the aid of a sheepherder, Mr. Dowling found a fine new Mosasaur, evidently a *Clidastes*, as the chevrons are anchylosed to the centra of the vertebræ and the end of the tail is expanded into a fin. We secured the mandibles with teeth, a lot of dorsal vertebræ, and nearly 15 feet of the tail. We also collected some fine Ammonites and Baculites as well as a couple of specimens of a Plesiosaur, resembling *Cimoliosaurus*. These fossils can not be distinguished from similar ones we procured from the Fort Pierre above the Belly River series in Dead Lodge Canyon on the Red Deer River, Alberta. But for the uplifting of the rocks the stratigraphical record would be quite simple. A little observation, however, enabled one to detect the different horizons readily. On the ground it would be impossible for one to doubt the sequence of the rocks as given by Hatcher and Stanton in the order beginning at the bottom, Eagle Sandstone, Claggett shales, Judith River Beds and Bear Paw shales on top of all.

We followed the same trail first traveled by Professor Cope down the prairie level to near Cow Island, getting water at "Lone Tree" spring as in 1876, and camped near our old camp, on the Missouri River. We found the Bear Paw shales on top of the Judith River Beds, on the south side of the river three miles below Cow Island. The only difference between the formation here and Dog Creek is the absence of the Eagle Sandstones and Claggett shales. The sculpture and lithological characters of the bad lands approached more

nearly those of the Dead Lodge Canyon on the Red Deer River. Two things have especially impressed me: First, the close resemblance between the Judith River Beds and the Belly River series in the Dead Lodge Canyon where the Fort Pierre on top and Belly River series below are nearly 500 feet thick. Towards its lower end a sandstone like the Eagle is exposed. The second is the finding of a footed ischium of a trachodont in the same bed from which the type of *Trachodon mirabilis*, of Leidy, was discovered, the same teeth to which he gave the name lying around the ischium. That evidently belongs to Lambe's *Stephanosaurus marginatus*: a crested trachodont. My party has already discovered three trachodonts in the Belly River series, two with footed ischia and one Lambe's *Gryposaurus notabilis*, has an uncrested head. We have only found among our forty tons of fossil dinosaurs collected there a single species of *Trachodon*. The one we mounted from the Edmonton is certainly one. Is it possible, then, that Leidy's *Trachodon mirabilis* was a crested duck-bill? This is a question impossible of solution, as the type tooth might have come from one of three or four of the Trachodonts of the Belly River series. Then the use by Marsh of two horn cores to found the genus *Ceratops* on and the family *Ceratopsia* rests on a shaky foundation along with Cope's *Monoclonius*. These horns of Marsh might have come from any of the horned dinosaurs of that time except *Centrosaurus*, and in spite of the splendid and complete skulls of horned dinosaurs we have secured from the Belly River series we know nothing of *Monoclonius* except what little, if anything, can be learned from the types.

Then the richness of the fauna in genera and species both of duck-billed, plated, horned and carnivorous dinosaurs, was at high tide during Belly River time. The formation, therefore, must have covered a wide area, and it is not surprising to know that Brown got a *Gryposaurus* skull in New Mexico. A thorough exploration of the beds in Montana will doubtless yield rich returns. It is also interesting to note that I got a plated dinosaur some years ago in the Niobrara Chalk of Kansas, described by Weiland, doubtless a near relative of Lambe's *Europlocephalus* from the Red Deer River. Evidently then the Cretaceous dinosaurs continued to live and thrive through Cretaceous time in the west, but few bones found lodgment in the ocean sediment of thousands of feet of Dakota, Fort Benton, Niobrara, Fort Pierre and Fox Hills groups. It appears evident, too, that the life of the Pierre ocean was continuous with the Belly River, whose shores were only raised a few feet above tide water. Many Plesiosaurs found entrance to the freshwater lakes and mingled their bones with the reptilian fauna. Hatcher himself once told me he believed all the beds of the Judith River region were Pierre from top to bottom, though I suppose land, fresh water and marine beds will always be known by different names.

CHARLES H. STERNBERG

THE TRAVERTINE RECORD OF BLAKE SEA

AN outlying mass of fragmental granite projects from a spur of the Santa Rosa Mountains into the Cahuilla basin in southeastern California, the crest of the rocks rising above the ancient shore line of Blake Sea, which filled the basin to a level, something above that of present high tide in the Gulf of California.[1]

This cape is designated as "Travertine Point" in our publications, as the surface of the granite boulders is covered to a varying depth with dendritic and lithoid tufa.[2] Some marks and figures presumably carved by Indians in the travertine have long been known and were seen by us on our first visit to the place in 1906. In the continuation of our work on the Salton Sea it was realized that these figures might possibly yield some evidence as to the duration, and variations in level of the ancient Blake Sea, and of the smaller modern Salton Lake.

A visit to the formation was accordingly

[1] See Plate 1, "The Salton Sea," MacDougal, *et al.*, Publ. Carnegie Institution of Washington, No. 193, 1914.

[2] See Jones, J. C., "The Geologic History of Lake Lahontan," SCIENCE, XL., p. 827, 1914.

made in March, 1915, and a careful inspection showed that the number of carvings on the rock was very large, and that some have been coated over to such depth that they may be made out only in the most favorable illumination or shading. Others show as deep furrows with weathered surfaces, visible at a hundred yards or more, while none of recent origin have yet been found.

A slice of the travertine extending across four lines of a complex pictograph and down to the granite base was cut out, and the surfaces of the sample are now being polished and prepared for critical examination. Some time may be required to determine the degree of uniformity, or of differentiation into layers which might indicate more than one period of deposition, and a series of such samples may be necessary for the reconstruction of the history of Blake Sea and of Salton Lake.

The carvings were apparently not made in the granite, but in the travertine, and extended study may be necessary to determine the depth at which the figures were made, and what deposition and weathering has since taken place. The facts favor the presumption that Blake Sea was a fluctuating body of water and not a continuously receding one. The final proof of the matter will rest chiefly upon biological evidence concerning the activities of organisms in connection with the deposition of tufas, to which the botanist may be expected to contribute.

D. T. MacDougal,
Godfrey Sykes

Desert Laboratory

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 486th meeting of the society, held April 6, Dr. Gudmund Hatt, of the University of Copenhagen, read a paper entitled "At Home with Lapps and Reindeer," illustrated with lantern slides. About 6,000 of the 30,000 Lapps are nomads and retain much of their old culture, because old habits and thoughts are necessarily connected with their nomadic life. The Lappish world is full of supernatural powers that seem to be recruited from the ghosts of the dead. An underground people, generally invisible, called "saivo," are believed to be reindeer breeders. The shaman sometimes goes to the saivo world to secure the recovery of a sick person and until recently offerings were made to it to prolong life. Vagrant spirits, "muones," bring sickness. There are also local spirits, not spirits of the dead, who inhabit and own certain localities. Every part of the lodge is connected with supernatural powers. The place behind the fire is sacred. Lapps are considered great magicians, the main purposes of their art being to bring sickness and death and to cure sickness. The evil influences that bring sickness are driven away by terrifying the hostile power. Again, the sick part may be touched by the object from which the evil came, in order to cure it. The idea of reindeer luck is characteristic. Until lately, sacrifices were in vogue to insure it. No bone must be broken in the sacrifices of reindeer. The bones were formerly sometimes placed in a spring. Formerly the same deity presided over the birth of children and of reindeer calves. To take the life of a human being will buy reindeer luck.

At the 487th regular and 36th annual meeting of the society, held April 20, Dr. Henry R. Evans, of the Bureau of Education, read a paper on "The Old and New Magic." In addition to explanations given in his book under this title, the doctor explained that thought transference and even hypnotism might be the real explanation of the phenomena exhibited by so-called mediums and clairvoyants. Dr. Gudmund Hatt said that Lapps caused and cured sickness through hypnotism and practised second sight. Mr. Mooney gave instances of hypnotism as practised by medicine men among American Indians. Mr. J. N. B. Hewitt, Mr. Francis La Flesche, and Dr. E. L. Morgan related their observations upon sleight-of-hand and other tricks practised among the Iroquois, the Pawnees, and other tribes. For example, "arrows" made of pliable vines were swallowed; also other objects by means of a tube inserted in the throat. Iroquois jugglers forfeited their life unless each produced a new trick at the annual meeting of the jugglers and correctly told the dreams of others.

The following officers were elected for the ensuing year: Dr. John R. Swanton, President; Dr. I. M. Casanowicz, Vice-president; Dr. Daniel Folkmar, Secretary; Mr. J. N. B. Hewitt, Treasurer; and Messrs. William A. Babcock, Francis La Flesche, George C. Maynard and Felix Neumann, and Dr. Edwin L. Morgan were elected Councilors.

Daniel Folkmar,
Secretary

SCIENCE

FRIDAY, JULY 30, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

EXPERIMENTAL AND CHEMICAL STUDIES OF THE BLOOD WITH AN APPEAL FOR MORE EXTENDED CHEMICAL TRAINING FOR THE BIOLOGICAL AND MEDICAL INVESTIGATOR[1]

BEFORE beginning my address let me say that I feel it to be a very great honor to have been asked to deliver the first Mellon Lecture under the auspices of the Society for Biological Research of this university. The establishment of a lectureship of this character is a great encouragement to men of science. It affords additional opportunity to bring to the attention of a wider public the recent results of scientific investigation as well as to emphasize again a truth which can not be too often repeated, that science constitutes a sure and lasting part of the intellectual treasure which mankind possesses.[2]

I have ventured to take as the subject of my address some recent experimental and chemical studies of the blood. In order to give my subject a proper setting I must, first, refer briefly to the history of blood-letting, and to make clear its relation to pressing medical problems, I shall in the hour discuss the interaction of the blood and the organs of internal secretion.

The overwhelming significance of the blood to all people in all times is shown in folk sayings, in tradition and in literature. The expressions, "the life of flesh is in the blood," "tainted blood," "blood will tell," "blood oath," "blood brother," all suggest how nearly blood has been held to be synon-

[1] The first Mellon lecture, delivered in the Assembly Hall of the Mellon Institute, Pittsburgh, on February 27, 1915.

[2] Ostwald,

ymous with life. It was an ancient Celtic custom to emphasize the inviolability of a treaty by having it written with the blood of both clans mixed in one vessel.

In the earlier systems of medicine, as those of Asiatic countries, of Egypt and of Greece, alterations in the composition of the blood were held to be of great significance. In Hippocratic medicine the right admixture of the four humors, the blood, phlegm, yellow bile and black bile, constituted health, while wrong proportions or distribution caused disease. This humoral theory of disease, variously modified down to our own time, has always fitted in well with the practise of blood-letting, or making running issues, and with other depletory measures.

Blood-letting seems, however, to antedate all systems of medicine and to have been one of the earliest therapeutic procedures applied by primitive races. Leeches have been used for this purpose since the earliest times in Asiatic countries, especially in India, and let no one suppose that their use has been discontinued in our day. Dr. Shipley, the master of Christ's College, Cambridge, writing in the *British Medical Journal*,[3] tells us that the Allies and Germans are now fighting on some of the best leech areas of Europe, and goes on to state that the traffic in leeches probably reached its height in the first half of the nineteenth century, that, for instance, in the year 1832, 57,500,000 of these annelids were imported into France, 60,000 to 80,000 leeches a day frequently leaving Strassburg for Paris, having been shipped overland from Hungary *via* Vienna. So great was the demand that the artificial cultivation of leeches was taken up in various countries and became a profitable industry. And now a new use for leeches has arisen. Certain glands surrounding the oral end of the digestive canal of this annelid secrete a remarkable substance which keeps blood from coagulating and which has been named hirudin. This substance is much used in our laboratories to keep the blood of man and animals in the fluid state. Leeches have thus become an article of commerce quite aside from their employment as depleting agents, and the demand is constantly growing. We are at present greatly hampered by our inability to obtain them from Europe, as their importation has practically ceased since the outbreak of the war.

It is not my purpose to attempt to give a history of blood-letting, even in abstract; the history of the subject is practically coextensive with the history of medicine itself. I must therefore content myself with a few selections from historical writing which will demonstrate to you that the influence of this method of treating disease has been paramount since long before the time of Hippocrates, whose writings furnish one of the earliest prescriptions for blood-letting, beginning with the direction to

> Bleed in the acute affections, if the disease appears strong, and the patients be in the vigor of life, and if they have strength.

In the latter part of the twelfth century, when universities as we now know them were coming into existence, there originated in the School of Salernum the "Regimen Sanitatis Salerni" or "Code of Health," a poem written in Latin hexameter verses and giving the medical notions of the day, as derived from the Arabic writers in regard to blood-letting, diet and personal hygiene. The high value placed on the "Regimen" may be seen from the fact that it passed through some 240 different edi-

[3] No. 2813, November 28, 1914, p. 917, and No. 2814, December 5, 1914, p. 962. These papers contain much valuable information concerning the medicinal leech, as also the curious history of exotic leeches which in certain eastern countries constitute a serious menace to the life of men and animals.

tions and was translated into all the known languages.[4] In general praise of blood-letting the poem[5] says

Bleeding the body purges in disguise,
For it excites the nerves, improves the eyes
And mind, and gives the bowels exercise,
Brings sleep, clear thoughts, and sadness drives away,
And hearing, strength and voice augments each day.

Other verses give directions as to what months are proper and what improper for bleeding, tells what diseases are benefited by blood-letting and in what quantities blood should be drawn, and the effect of age and other circumstances.

Acute disease, or only so in part,
Demands bloodletting freely from the start.
In middle age, bleed largely without fear,
But treat old age like tender childhood here.

In the latter part of the middle ages blood-letting was carried to great excess. During this period astrology strongly influenced medical thought, and physicians made diagnoses and bled their patients according to the position of the planets, constellations and single stars (horoscopic medicine). For their greater convenience semi-popular calendars were even prepared with illustrations such as the so-called venesection manikins of Johann Nider von Gemünd (1470) and of Stoeffler (1518) with directions as to the vein to be opened for the cure of each malady.

In the sixteenth and seventeenth centuries we come upon heated controversies between the upholders of the Hippocratic and of the Arabian theories of blood-letting. By the former method it was thought that the vein to be opened should be as near as possible to the diseased part—in order that the "foul and stagnant" blood might be directly removed from the inflamed area ("derivation"). On the other hand, the doctrine elaborated by the Arabians taught that blood should be taken from a vein remote from the inflamed part, for instance, in inflammation of the lungs and pleura, from the arm or even the foot of the opposite side, with the idea that this process ("revulsion") prevented good blood from accumulating in the diseased part.

This latter doctrine was in the ascendancy in European countries in the sixteenth century, but the learned Pierre Brissot (1478–1522), basing his opinion on his own large clinical experience in Paris in 1514, when an acute affection of the lungs was prevalent, revived the Hippocratic method of bleeding and thus started the famous Brissot-venesection controversy in which most of the great men of the century, including Vesalius, took part. The importance attached to the controversy at the time is shown in the fact that the opponents of Brissot induced the French Parliament to forbid the practise of his method, and their attacks were so bitter as virtually to drive him from Paris and his professorship. Haeser[6] informs us that the quarrel assumed such violence that when the University of Salamanca took sides with Brissot, the Emperor Charles V., who was called on to render a "decision" in the matter was assured that the new false doctrine was no less dangerous than the heresy of Luther.

While Brissot was anything but a "therapeutic nihilist" as to breeding, and held firmly to the doctrine that the "foul blood" of the inflamed area should be removed, some of his followers rejected bleeding altogether in acute disease of the lungs and pleura (the pleuritis of that day). Their moderation was looked upon as little less than heretical, and toward the end of the sixteenth century we find Leonardo Botallo, a Piedmontese, an eminent prac-

[4] Garrison, "The History of Blood-letting," *N. Y. Med. Jour.*, March 1 and 8, 1913.

[5] Professor John Ordronaux's translation.

[6] *Geschichte der Medicin*, II., p. 64.

titioner of his time, chief physician to Charles IX., advising venesection to the limit, regardless of the nature of disease, the age or condition of the patient. Blood-lettings of three to four pounds each repeated as often as four or five times were advised, says Haeser, and this historian adds that the explanation of this "Vampyrismus" is probably to be found in the circumstance that Botallo lived in northern Italy, where diseases of an inflammatory character were prevalent and more especially that in his experience as an army surgeon he encountered only patients of the most robust type. Botallo, in defending his practise said,

> the more foul water is drawn from a well, the more good water can flow in to replace it.[7]

An ardent follower of Botallo was Riolan the younger, who falls back upon Hippocrates and Galen and lays down the rule that one must take away as much blood as possible in every disease. As an adult is judged to have about thirty (!) pounds of blood,[8] the tapping of half this amount, or fifteen pounds, in the course of fourteen days would be about the right amount to take, says Riolan. Guy Patin (1602–1672), himself an ardent bleeder and purger, informs us that Bovard, body physician of Louis XIII., bled that monarch forty-seven times, gave him 312 clysters and prescribed emetics and purges, 215 times, all in one year.

A little later, that able and credulous Belgian mystic and follower of Paracelsus, J. B. Van Helmont (1578–1644), an iconoclast in general, called by his admirer Haeser "the fist of the seventeenth century" went so far as to condemn venesection entirely. To him is attributed the often-quoted phrase "a Bloody Moloch presides in the chair of medicine."

Also as holding that in place of excessive blood-letting should be substituted therapeutic procedures ("alterantia") and change of diet, stands the genial and talented Franciscus de le Boë (Sylvius) (1614–1672), one of the leading medical authorities of the seventeenth century and one of the earliest defenders of Harvey's doctrine of the circulation, who taught at Leyden that abnormal fermentations in the fluids of the body cause disease, a variant of the ancient humoral doctrine. In Chapter XX. of his "New Idea" (translated by Richard Gower, London, 1675), entitled "On the Motion of Blood through the Lungs Affected," he shows his good sense and his caution when he says

> *A Plethora of Blood* is soon and safely *cur'd*, by a sufficient *Emptying* of it by *opening a Vein;* whether it be together and at once, or by repeted turns, according to the peculiar nature and strength of the *Sick*. For there are many who can not bear to have much taken away together, but soon fall into a Swouning; by which feeling none can at any time receive any good, I had rather that it should be prevented, as often as may be, and every Cure be done securely rather than rashly, seeing it often happens to those rash Blood-Letters, that they educe Life together with Blood.

An instance of lavish blood-letting in a medical crisis may be found in the experience of that adventurous spirit, Thomas Dover, to whom we owe the much used "Dover's powder." In 1708, Dover, then forty-eight years old, set out on a privateering expedition and was given command of a ship, the *Duke*, while his superior, Captain Woodes-Rogers took command of the other ship of the squadron, the *Duchess*. The three years' voyage of these buccaneers is of interest historically because,

> touching at the island of Juan Fernandez, they took on board Alaxander Selkirk, who had lived alone on the island for four years and four months, and whose story was to develop in the skilful hands

[7] Bauer, *Geschichte der Aderlässe*, Gekrönte Preisschrift, Munich, 1870, p. 139.

[8] Bauer, *loc. cit.*

of Defoe into that of the immortal "Robinson Crusoe."[9]

In Dover's "Ancient Physicians Legacy to his country" we find the following interesting passages:

When I took by Storm the two Cities of Gualaquil, under the Line, in the South Seas, it happen'd, that not long before, the Plague had raged amongst them. For our better Security, therefore, and keeping our People together, we lay in their churches, and likewise brought thither the Plunder of the Cities.

. . . In a very few days after we got on board, one of the Surgeons came to me, to acquaint me, that several of my men were taken after a violent Manner, with that Langour of Spirits, that they were not able to move. I immediately went among them, and, to my great Surprise, soon discerned what was the Matter. In less than Forty-eight Hours we had in our several Ships, one Hundred and eighty Men in this miserable condition.

I order'd the Surgeons to bleed them in both Arms, and to go round to them all, with Command to leave them bleeding till all were blooded, and then come and tie them up in their Turns. Thus they lay bleeding and fainting, so long, that I could not conceive they lost less than an hundred Ounces each Man.

If we had lost so great a Number of our People, the poor Remains must infallibly have perished. . . .

We had on board Oil and Spirit of Vitriol sufficient, which I caused to be mixed with Water to the Acidity of a Lemon, and made them drink very freely of it; so that notwithstanding we had one hundred and eighty odd down in this most fatal Distemper, yet we lost no more than seven or eight; and even these owed their Deaths to the streng Liquors which their Mess-Mates procured for them . . . Now if we had had Recourse to Alexipharmicks, such as Venice Treacle, Diascordium, Mithridate, and such-like good-for-nothing Compositions, or the most celebrated Gascoin's Powder, or Bezoar, I make no Question at all, considering the heat of the Climate, but we had lost every Man.

Of non-medical literature the Satire of Gil Blas, written early in the eighteenth century, but in reality giving a picture of seventeenth-century excesses in blood-letting, is worth citing.

Dr. Sangrado is called in to prescribe for a gouty old canon, and he at once sends for a surgeon and orders him to "take six good porringers of blood in order to supply the need of perspiration." The surgeon was ordered to return in three hours and take as much more and to repeat the evacuation the next day. The patient was "reduced to death's door in less than two days," and, the notary being summoned to make the will, seized his hat and cloak in a hurry when he learned from the messenger, Gil Blas that Dr. Sangrado was the physician. "Zooks," cried he, "let us make haste, for the doctor is so expeditious that he seldom gives the patient time to send for notaries; that man has choused me out of a great many jobs."

But the misuse of bleeding continued in the centuries following, and at no time was the practise more abused than in the latter part of the eighteenth or even in the first five decades of the past century. French and Italian authorities, especially, were great believers in blood-letting. Broussias (1772–1832) is said to have used 100,000 leeches in his hospital wards in one year. This physician and his follower, Bouilland, actuated by false theories of the cause of fevers, recommended the bleeding of a patient 10 to 12 and even 20 times in the course of treatment.

But more and more the opponents of general and excessive bleeding made headway in their respective countries. Many are the names that might here be named, as Pinel, Andral, Louis in France, Dietl the pupil of Skoda and Wollstein the professor of veterinary medicine in Vienna, Mezlar, Rademacher, von Pfeufer and others in Germany, Marshall Hall[10] and later Sir

[9] "Chronicles of Pharmacy," Wootton, II., p. 130.

[10] "While Marshall Hall favored Venesection, he was one of the earlier and important members of

William Jenner, Sir William Gull, Bennet and others in England, Strambio, Angelo, Meli in Italy, and Jackson in our own country, and many others in all of these countries.

But what finally led to the entire abolition of bleeding after the middle of the past century was not so much the opposition of clinicians who failed by its use to abort pneumonia ("the queen of inflammations," as Dietl calls it) or some other acute disease, but the rise of new theories of disease, based on discoveries of fundamental importance. The rise of the cell-theory and of cellular pathology, the discovery of bacteria and their connection with the inflammatory process of the infectious diseases, the appearance of hydrotherapy, the expectant medicine of the school of Skoda and Oppolzer, new and quicker methods of obtaining the effects of drugs, as by means of the hypodermic syringe, the discovery of new hypnotics, of the analgesics and anesthetics, altered the views of medical theorists and practitioners alike and inevitably led to the downfall of the theories on which venesection had been based.

During a period of study of six and a half years, from 1884 to 1891, as a student of chemistry and medicine in several of the larger medical centers of Germany, Austria and Switzerland, I never once saw a patient bled in clinic or hospital. The procedure may have been employed now and then, but so little stress was laid upon it that it was not thought worth while to demonstrate it to the young men who walked the wards.[11]

Bleeding did not disappear, however, from the world. The common man, especially in Germany and France, still held firmly that benefits did follow the use of the wet cup, the lancet and the leech. Tenaciously the old practises were upheld. If physicians refused to bleed, there was always the barber surgeon, fully competent, as in teeth pulling, to give relief. I remember that in my boyhood in Ohio the practise of blood-letting in the spring of the year was in vogue among the farm laborers from southern Germany. After their return from a visit to their barber surgeon in the town the scarified backs were exhibited as a special favor, and irrefutable arguments advanced in respect to the benefits of bleeding either to ward off disease or to improve nutrition. Was it not true and known to all stock-breeders that the domestic animals could be fattened by judicious bleeding at certain fixed intervals?

And it appears now that the common man was right, after all. An empirical method of treatment which has been practised by nearly all races since before the day of Hippocrates almost certainly contains a basis of truth. This is now admitted, and physicians are again saving lives by the judicious and timely use of blood-letting. Says the experienced Sir T. Lauder Brunton:

> Blood-letting not only relieves symptoms, but may save the patient's life, as in engorged conditions of the right heart, whether due to mitral incompetence or pulmonary affections.[12]

the profession to throw doubt upon indiscriminate bloodletting." D'Arcy Power, "Dr. Marshall Hall and the Decay of Bloodletting," *The Practitioner*, 1909, Vol. 32, p. 320.

[11] See also F. de Havilland Hall, The Westminster Hospital Reports, Vol. XVII., p. 1, 1911, who make the following statement in a clinical lecture on bloodletting: "To such an extent had bleeding been discarded that during my student days at St. Bartholomew's Hospital, I never heard of a patient being bled, so that I was quite taken back, when shortly after I was appointed House Surgeon at a country hospital, the Senior Surgeon came to me to be bled. Indeed, in 1892 when I requested a member of the Surgical Staff at St. Bartholomew's to bleed a patient for me, he told me that this was the first time he had ever been called upon to perform phlebotomy."

[12] On the use of leeches in relieving overdistension of the right heart, in cases of pneumonia, see

In puerperal eclampsia, to mention but one more instance, we also have a condition which is generally strikingly benefited by blood-letting.[13]

Venesection, then, will probably never again be entirely excluded from medicine, as it was during the last quarter of the past century, nor need we fear that the practise will be again misused.

PLASMAPHERESIS

But venesection, like all therapeutic procedures, has certain drawbacks which prescribe limits to its use, and these drawbacks are inherent in the very composition of the blood and in the nature of the circulatory apparatus. As is known to all the oxygen-carrying power of the blood resides in the red corpuscles, or erythrocytes, which constitute about 36 per cent. of the volume of the blood. These erythrocytes, like other cellular constituents, can be built up only slowly in the body by the hemapoietic, or blood-building, organs. It is apparent, therefore, that the bad effects of overbleeding, as formerly practised, must be due mainly to the loss of these cellular elements. Common experience has shown that the loss of too much blood is either immediately fatal, or else is followed by a prolonged illness, recovery from which is often doubtful.

Reflecting on these drawbacks I conceived the idea that the main objection of blood-letting could be obviated by the speedy return into the body of the red and the white corpuscles instead of throwing them away as hitherto has been our custom. The only thing that would be removed from the blood of a person bled in this way would be its fluid part—the plasma. If this method were found to be practicable the value of bleeding would be enhanced and its field of application extended. Such a method, if successful, would appear to be advantageous for the patients, not only in those instances in which venesection is performed, admittedly with good results, but would also open the way for the withdrawal of fluid when it is desired to decrease the volume of blood in the vascular apparatus or to remove excess of deleterious substances, or where bleeding has hitherto been contraindicated because of the danger of reducing the oxygen-carrying capacity of the blood, as, for example, in aneurism, or in cardiac decompensation with a low blood count.

In the work now going on in my laboratory, we are still in the stage of experimentation and study, but our experiments on animals have proved the feasibility of the method. With the skilful cooperation of my colleagues, Drs. Rowntree, Turner, Marshall and Lamson, a considerable number of experiments on animals have already been made. Our procedure, in a word, is the following. Blood is withdrawn freely from an animal and is prevented from clotting by addition of leech extract; Locke's fluid in equal volume is then added to the blood, and the mixture is sedimented in the centrifugal machine until the corpuscles have settled out in the flasks. The supernatant plasma is then drawn off and replaced by Locke's fluid, the corpuscles are stirred up and the new mixture is returned to the animal. By repeating this process it has been learned that blood-letting can be carried out repeatedly, without endangering the life of an animal, provided only that the cellular elements of

D. B. Lees, *Lancet*, February 25, 1911. Also for cases in which blood-letting (either by venesection or by means of leeches) may be advantageously employed, see F. de Havilland Hall, Westminster Hospital Reports, Vol. 17, p. 1, 1911.

[13] See Zweifel, "Zur Behandlung der Eklampsie," *Centralbl. f. Gynäkologie*, 1895, No. 46. Alexander Strubell, "Der Aderlass, Eine Monographische Studie," Berlin, 1905.

the blood are returned. We have named the procedure plasmapheresis.

It is apparent that when blood-letting is practised in the usual way there is always the risk of greatly reducing the oxygen-carrying capacity of the blood through loss of red corpuscles, but in our experiments the fluid of the blood can be withdrawn in large quantities without affecting this capacity, as far as we can determine at the present moment. Just how large quantities of plasma can be withdrawn without permanent injury can not at present be stated. In certain cases very large amounts have been successfully removed in experiments extending over several days. We have actually withdrawn from a dog by repeated bleedings in a *single* day, a volume of blood more than twice that contained in the body, with no apparent injury, by our method of returning the corpuscles after each bleeding. How far this exceeds the quantity of blood that may be safely removed from a dog at one time without return of corpuscles is seen when we recall that the loss at one time of 60 to 70 per cent. of the animal's blood is quickly fatal.

It may yet be possible to attach an electrically controlled centrifugalizing apparatus directly to the blood vessels of an animal and tap off a desired quantity of the fluid part of the blood while directing the stream of corpuscles back into the body (or vice versa), the whole apparatus being analogous in a way to the modern cream separator.

It has been our purpose in our recent experiments to find the limits to which the plasmapheresis may be carried and to learn what pathological changes ensue when the procedure is carried to a point beyond which life is endangered. With the form of Locke's solution now employed by us, we have in the course of five days carried the removal of plasma to a point where the total volume of blood withdrawn from the body equals at least five times that ordinarily contained in the body. In this experiment the limit of the procedure was probably reached, as the animal was very nearly lost during the last bleeding; only the speedy return of the sedimented corpuscles saved the dying animal. Unfortunately, one can not conclude from these most successful experiments that similar or even markedly lower quantities can always be removed without danger. We have recently carried out a large number of experiments with a view to determine the safe limits of plasmapheresis both as to quantity per day and total quantity of blood withdrawn, but unfortunately these experiments are vitiated by an error which has only recently been discovered. It has been found that the imported hirudin which we are now using is strongly toxic. This was not the case with the product which we ourselves manufactured and which was used in our earlier experiments. Further experiments will have to be done, therefore, to settle this question.

Some interesting results have been obtained by studying the chemical changes during plasmapheresis. Since the method consists essentially in replacing the plasma of the blood by a saline solution, it is natural to find a decrease in the soluble proteins of the blood. While not as rapid as a purely mathematical calculation based on the amounts drawn off and returned would indicate, if the vascular system were regarded as a vessel of given capacity to be washed out, the decrease is considerable. In three days the soluble proteins have been reduced to about one third their original value, after which there is a slight rise as the process is continued. Evidently, as was expected, there is a continual renewal of plasma proteins from the tissues.

In striking contrast to this, the non-

proteid nitrogen of the plasma shows a slight *rise* on the first day in every case studied, and a tendency to rise, with some fluctuations, as the process is continued. This increase, which is chiefly due to urea, may be due either to an increase in nitrogenous katabolism or to a diminution of nitrogen excretion.

TABLE I

Plasmapheresis on Three Dogs for Several Days. Nos. 8 and 11 Three Days Each, No. 10 Two Days

Experiment No.	8	10	11
Weight before operation	9.6 kg.	12.8 kg.	8 kg.
(Estimated) blood volume	730 c.c.	960 cc.	600 c.c.
Total blood drawn	2,037 c.c.	2,046 c.c.	1,835 c.c.
Ratio of volumes	2.79	2.13	3.06
Weights, July 8	10.5 kg.	11.8 kg.	8.5 kg.
Weights, July 10	10.7 kg.	12.5 kg.	8.0 kg.
Weights, July 15	11.2 kg.	12.8 kg.	8.2 kg.
Blood count (millions) July 8	4.5	5.3	
Blood count (millions) July 9	4.6	5.9	6.5
Blood count (millions) July 13	4.2	5.5	5.1
Blood count (millions) July 16	5.2	6.2	5.8
Haemoglobin, July 8	52 %	74 %	
Haemoglobin, July 9	52 %	65 %	78 %
Haemoglobin, July 13	60 %	80 %	79 %
Haemoglobin, July 16	65 %	79 %	80 %
Weights, July 22	11.0 kg.	13.35 kg.	8.5 kg.
Blood count, July 22	4.1	5.4	5.3
Haemoglobin, July 22	72 %	80 %	75 %

Studies have also been made of blood pressure and blood counts. Plasmapheresis, like hemorrhage, causes a seemingly paradoxical increase in the number of red cells per unit volume of blood. This, which appears to be a general phenomenon accompanying temporary asphyxia, is being investigated in all its bearings by Dr. Lamson.[14] The blood pressure, which falls on bleeding, is restored to a satisfactory value on returning the corpuscles and, for a long period the two changes may nearly compensate each other. A slight downward tendency is noticed, however, as plasmapheresis is continued, and in the end a dangerously low point (about 50 mm.) will be reached on withdrawing amounts of blood considerably smaller than those taken at the start. The previous bleeding usually shows a fall to a point (from 60 to 80 mm.) which should be regarded as a warning. even though 100 mm. or more may be reached on reinjection.

The following tables give in condensed form some of the data to which reference has been made in the foregoing pages.

TABLE II

Chemical Analyses. Plasmapheresis for one day, on three dogs

	Date					
	Dec. 21		Jan. 11		Jan. 18	
Weight of dog	15.1 kg.		11.9 kg.		7.1 kg.	
Blood volume estimated at 7.5%	1,132 c.c.		892 c.c.		532 c.c.	
Total volume bled and % of total blood	1,185 c.c. = 105%		1,150 c.c. = 129%		410 c.c. = 77%	
Number of bleedings	3		3		5	
Results of analyses, percentages	Before plasmapheresis	After plasmapheresis	Before plasmapheresis	After plasmapheresis	Before plasmapheresis	After plasmapheresis
Total protein of blood	22.27	25.23	25.15	25.32	17.34	17.19
Protein of plasma	6.62	3.63	6.59	3.17	6.28	3.68
Difference of above[15]	15.65	21.60	18.56	22.15	11.06	13.51
Blood counts, millions	9.0	11.7	11.8	12.9	6.6	7.5
Total non-proteid N	0.037	0.039	0.029	0.036	0.045	0.055
Urea nitrogen	0.016	0.019	0.011	0.017	0.016	0.023
Non-urea nitrogen	0.021	0.020	0.018	0.021	0.029	0.032
Aminonitrogen	0.0041	......	......	......	0.0048	0.0048

[14] "Polycythemia," P. D. Lamson, *Jour. Pharm. and Expt. Ther.*, VII., No. 1, July, 1915.

[15] Blood taken for analysis not included unless made up by equal amount of washed corpuscles from other dogs.

TABLE III

Continued Plasmapheresis on a Dog for Five Successive Days

Exp. No. 6, Jan. 22 to 26, inclusive. *A* before plasmapheresis, *B* after plasmapheresis.

Weight of dog 8.5 kg. Estimated blood volume (7.5 per cent.) = 640 c.c. Total blood removed in five days, 3,335 c.c. = 521 per cent. Analytical results in percentage of total blood.

	Date.				
	A Jan. 22	*B* Jan. 22	*B* Jan. 24	*B* Jan. 26	Feb. 19
Total protein of blood	19.28	19.31	16.81	15.83	11.78
Plasma protein	6.38	3.44	2.23	2.92	5.75
Difference of above	12.90	15.87	14.58	12.91	6.03
Blood count millions	8.5	8.5	7.5	6.5	3.5
Total non-protein nitrogen	0.035	0.040	0.037	0.042	0.030
Urea nitrogen	0.013	0.019	0.014	0.021	0.012
Amino nitrogen	0.0047	0.0056	0.0033	0.0059	0.0038

The results obtained in continued plasmapheresis are shown in Table III. The amount of blood taken was about one volume on each day. The first two columns of analytical results, obtained with samples taken at the beginning and end of the day's work, compare closely with those in Table I. The third column shows the results at the end of the *third* day's work, when the plasma protein reached the lowest value, 2.23 per cent. The fourth column gives the results at the end of five days of plasmapheresis, while the last column shows the results twenty-four days later. Here the plasma protein has gone up again nearly to its original value. The corpuscle protein, and consequently the total protein, also, are low, owing to the anemia.

VIVIDIFFUSION

I should like now to describe a second method for the study of the blood, and to state briefly some of the results that have

Influence of Plasmapheresis on Blood Pressure

Mean Systolic Pressures in Millimeters of Mercury
Exp. No. 6, Jan. 22 to 26, 1915, inclusive.

Day of Expt.	Volume Bled, C.c.	Bleeding		Return	
		Before	After	Before	After
1st	250	208	165	...	202
	250	115	65	95	135
	170	140	65	85	115
2d	200				
	125	pressures not observed on this day.			
	170				
3d	195	130	...	...	110
	210	130	60	...	110
	200	110	55	70	110
	185	135	50	...	105
4th	205	135	100	110	135
	200	135	105	100	120
	200	115	60	80	105
	135	95	50	75	105
5th	180	...	105	100	110
	190	120	52	65	105
	175	100	50	47	95
				1 hr. later =	110

already been obtained by its use. But first let me remind you that there are numerous constituents of the blood derived from various organs which are of the most vital significance to the economy and which are present in the blood in only minute quantity at any one time. Among these as yet unidentified substances, which nevertheless are certainly known to pass from one organ to others via the blood, are all of the so-called hormones, the active principles of the organs of internal secretion. Of these organs I shall presently speak more in detail.

Our present methods of blood analysis give us little help when we endeavor to *isolate and identify* one of these elusive yet vitally important principles, not to mention other substances of the greatest interest arising in the intermediary stages of metabolism.

Pondering over this problem, it occurred to me that possibly one might construct an apparatus which could be attached to the blood vessels of a living animal and re-

move from the blood flowing through it all traces of these substances as fast as they are poured into it, without at the same time removing proteids or the indispensable cellular elements (erythrocytes, leucocytes, etc.) of the blood. Such an apparatus might conceivably be employed also in an emergency in certain toxic states in which the eliminating organs, more especially the kidneys, can not act rapidly enough to relieve the system.

An apparatus of this kind was constructed with the skilful assistance of Dr. Turner. Essentially, the method consists in connecting an artery or a vein of the animal by a cannula to an apparatus made of celloidin or other dialyzing membrane, in the form of tubes, immersed in a saline solution or serum, and providing for the return of the blood to the animal's body by another cannula attached to a vein. The tubes and cannulæ are filled completely before attachment with a saline solution which approximates in composition to the salt content of the serum of the animal. This is displaced into the body by the inflow of blood, when the circulation in the apparatus is established. The blood leaving the artery flows through a perfectly closed system and returns to the body within a minute or two without having been exposed to contact with the air or any chance of microbial infection, while the diffusible substances which it contains can pass out, more or less rapidly, through the walls of the tubes. Coagulation of the blood is prevented by injection of hirudin. We have named the process vividiffusion and the apparatus itself constitutes an "artificial kidney," as it were, but differs from the natural organ in that it makes no distinction whatever between the various diffusible constituents of the blood, permitting their escape from the celloidin tubes in a manner which is presumably proportional to their coefficients of diffusion. As you are well aware, the natural kidney does not ordinarily allow the sugar of the blood to escape into the urine, its excretory function is elective and discriminatory. The artificial kidney, as just stated, makes no such distinction. Sugar is eliminated in proportion to its presence in the blood equally with a waste product like urea. We have it in our power, however, to give to this vividiffusion apparatus a certain selective ability, at least in the sense that we can prevent any given substances, as sugar, glycocoll, and the like, from escaping from the blood, by the simple expedient of placing an equivalent quantity on the outer side of the celloidin tubes.

With this apparatus we have already separated from the blood a number of constituents which can not be obtained with equal ease by other methods. I shall not here enter into the details of the chemical methods employed in differentiating the various constituents of the dialysate, but will merely point out some of the results that we have obtained.[16] It has been found:

1. That the non-protein constituents of the blood can be accumulated in any desired quantity by our method, the quantity depending on the extent of the dialyzing surface of our apparatus and the number of experiments made.

2. That the rate of accumulation of various nitrogenous substances in the dialysate and their relative proportions in it do not differ very greatly from those in the blood.

3. That alanine and valine can be obtained in crystalline form; that histidine and creatinine can be shown by reactions to be present.

4. Quite recently it has been found by

[16] See *Jour. of Pharmacology and Experimental Therapeutics*, Vol. V., pp. 275–317 and 625–44.

Dr. Alice Rohde, working in my laboratory, that the ammonia-yielding substances of the blood can be divided into two classes by the vividiffusion apparatus; the one, comprised of diffusible substances only and giving off their ammonia rapidly and completely on the addition of sodium carbonate; the other, non-diffusible and therefore not escaping through our apparatus, and characterized by the property of losing their ammonia only very slowly on the addition of sodium carbonate.

5. By means of our method of vividiffusion we have also found that oxyacids circulate in the blood in noticeable proportion. Lactic acid and β-oxybutyric acid in particular have been identified as constituents of the diffusate.

6. From the residue from one of the processes employed, that known as the "ester distillation," I obtained a crystalline substance having the composition $C_7H_{12}N_2O_2$. Dr. Turner and I were finally enabled to identify this substance as α-isobutyl hydantoin (1. isobutyl 2.4 diketotetrahydroimidazol) first prepared by Pinner and Lifschütz[17] and later by Fritz Lippich[18] from valeraldehydecyanhydrin and urea, also by E. Koenigs and B. Mylo[19] from *dl*leucinamid and ethylchlorcarbonate. I suspect that other hydantoins are present in the fraction from which this particular hydantoin was isolated. As α-isobutyl hydantoin is the first of its class to be isolated from an animal fluid or tissue, one must be certain that the substance has not been formed as a by-product of the many chemical processes that are involved in obtaining it; in other words, one is obliged to prove conclusively that the substance in question really exists, as such, in the blood of the dog. For the present we can not offer this final proof. Dr. Turner, however, is now engaged in searching for hydantoins in the blood of the pig by a method that will remove the uncertainty that still attaches to the find as it now stands.

7. Certain fractions of our dialysates, those derived from the so-called "phosphotungstic precipitate," have not yet been analyzed in detail, owing to the pressure of other parts of the problem; it is apparent, however, that we are dealing with an indeterminate number of substances, and it is more than probable that some hitherto unidentified constituents of the blood may here be found.

Half a year after we made our first communication[20] in which it was announced that we had separated from our dialysates several grams of amino-acid esters, Abderhalden[21] published a paper in which he describes the separation of some of the amino acids from large quantities of blood obtained from slaughter-houses. To secure the small amounts of amino acids needed for his identification tests this investigator was obliged to use at one time 50 or even 100 liters of beef blood. These large quantities of blood were worked up partly by dialysis, partly by precipitation methods which required the dilution of the blood by many volumes of water. The method of vividiffusion can be used in the most scantily equipped laboratory and has the great advantage of separating the diffusible substances from the proteids of the *circulating blood of living animals.* There can thus be no question here of secondary

[17] *Ber. d. d. chem. Ges.*, 20, p. 2,356 (1887).

[18] *Ibid.*, 41, p. 2,972 (1908).

[19] *Ibid.*, 41, p. 4,439 (1908).

[20] "On the Removal of Diffusible Substances from the Circulating Blood by Means of Dialysis," *Trans. Assoc. Americ. Physicians*, May, 1913. Also demonstration of our apparatus before the Pharmacological Section, Int. Med. Congress at London, August, 1913.

[21] *Zeitschr. f. physiol. Chemie*, Vol. 88, p. 478, December 28, 1913.

changes, such as may conceivably take place in shed and coagulated blood.

I come now to a newer application of the method of vividiffusion, one to which I alluded a few moments ago, namely its possible employment to abstract from the circulating blood certain hormones or products of internal secretion in amounts that will suffice for pharmacological study, if not for chemical analysis. This application is still in its very beginning, many difficulties yet remain to be surmounted, and I speak of it here only because it leads me quite naturally to a field of study which is of the greatest importance, a field which at present is ripe for the methods of the chemical explorer. I refer to the exploration of the organs of internal secretion, especially to the study by chemical methods of their specific products. In attempting this, a vividiffusion apparatus of the proper sort is attached to the veins of a particular organ, as the thyroid gland, and the diffusate thus obtained is studied by pharmacological and chemical methods. This diffusate must also be compared in respect to its pharmacological properties, at least, with both the arterial and the venous blood of the gland under investigation. But whatever may be the outcome of such studies, I hope to make it evident to you in what I am about to say that we are here dealing with matters of the greatest importance to biology and medicine.

JOHN J. ABEL
THE JOHNS HOPKINS MEDICAL SCHOOL

(To be continued)

THE RECENT ACTIVITY OF KILAUEA AND MAUNA LOA, HAWAII

THE volcanoes of Kilauea and Mauna Loa were both active during the past winter, furnishing the rather unusual spectacle of lava lakes within 22 miles of each other, but at a difference in altitude of practically 10,000 feet. The activity of Mauna Loa, as observed from Kilauea, lasted forty-eight days, from November 25, 1914, until January 11, 1915. At Kilauea, the first permanent open pool of magma was formed on October 3, 1914, and this pool increased in size and rose until a maximum height of 363 feet below the rim of the crater Halemaumau was reached on January 4, 1915. Since that time the lake has been slowly subsiding, with temporary rises and pauses. The activity of both volcanoes will be treated in some detail.[1]

The lava lake in Halemaumau, the crater of Kilauea, was visible from the autumn of 1907, which was six months after the cessation of activity on Mauna Loa, until the last of April, 1913. The maximum height reached during this long interval was 60 feet below the rim of the crater on January 1, 1912. During the autumn of 1912 the level of the lake was low, followed by a rise from November, 1912, until January, 1913. During January the lake sank; in February it was at about the same level as in the beginning of March, 1915; in March it sank almost out of sight after a brief rise on March 10; in April the lake was very low and very small, and finally went out.

During the summer of 1913, Halemaumau was an immense flat funnel of slide rock with the base at a depth of over 600 feet. The bottom of the pit was seldom seen on account of the dense fumes. Just before the time of the summer solstice, which reached a culmination on June 22, blowing noises were heard and a faint glow seen in the pit, indicating a slight rise of the lava. In the middle of July, the blowing noises recommenced and visible fire returned on July 23. An inner ring of fuming cones and a glowing chimney near the site of Old Faithful were seen. Once more the signs of activity ceased: the blowing noises did not recommence until the first of September, and a glowing cone near Old Faithful became visible September 24. The glow and the noises

[1] Weekly bulletins concerning the activity of the volcanoes, written by Professor T. A. Jaggar, Jr., and Mr. H. O. Wood, of the Hawaiian Volcano Observatory, are published by the Volcano Research Association. From these bulletins the data for the present paper, previous to the arrival of the writer at the volcano, are obtained. To Mr. H. O. Wood, and to Mr. Arthur Hannon, the writer is indebted for criticism.

continued through October very much as in October, 1912. In November there was a rise, accompanied by flows of lava from the glowing cones, so that in December there was a floor of black lava 200 feet long and 150 feet wide, at a depth of about 580 feet.

From the last of November, 1913, until March, 1914, conditions remained very much the same, with no more flows, but with a glow most of the time. Molten lava was ejected from the Old Faithful orifice to a height of 40 feet on March 6, and there was a short flow the next week. The next flows reported came in the early part of May, with a pool 25 feet in diameter at Old Faithful. This period of activity continued until the middle of June, when the floor had attained a depth of 530 feet. After the summer solstice, until July 26, there was a slower rise, with fewer flows than in May–June. From July 27 until August 5 a subsidence caused a collapse in the floor. An increase in activity caused a long flow on August 28, but there was no permanent increase until October 2, with a collapse of the Old Faithful cone the next day, forming an open pool 40 feet in diameter. On October 4, the pool had become triangular in shape, 100 feet long and 70 feet wide. The next day the pool was 200 feet long and 100 feet wide, with a depth below the rim of about 470 feet. By October 13 the pool had become 600 feet long, but was 28 feet lower. The subsidence continued, with the caving of the walls, until the twenty-second. On October 21, the lava was 518 feet below the rim, and on the twenty-third the lake was 375 feet long, 150 feet wide. From this date until November 6, the lake rose, and a flow 450 feet long came from a cone on the western corner of the floor. On November 16 the line of northeast cones and three northwest cones were engulfed in the lava, forming a northeast arm on the main lake and a separate northwest pond. The length of the lake was estimated, on the 17th, to be 400 feet, the east arm 150 feet long, the northwest pond 100 feet long, and a new northeast pond 12 feet long. The depth of the lake was about 469 feet. Three flows had developed along the floor; one from an east-border pot southward, one from the end of the new east arm northward, one from the north side of the northwest pond northward. The length of these flows was about 100 feet each.

The week preceding the outbreak of Mauna Loa witnessed a slightly less active condition in the Halemaumau lake than during the previous week. On November 19 the lake was 460 feet below the rim, with the current running from the west into the east arm. The east arm and the northwest pond were enlarged by collapse of the sides. Until December 1, the lake remained from 5 to 30 feet below the level of the floor, with daily fluctuations of level, reaching a maximum height about noon. Streaming, traveling fountains, and caves against which the lava splashed with surf noises were of common occurrence.

On December 2, two fresh flows were observed on the floor; one had come from the west end of the pit and spread along the west and north margins, the other from near the east cove and spread northward. The north boiling pot had enlarged almost to a small pool. On December 4, there was a small flow on the north side of the pit, glowing and hissing cones on the west floor and in the southwest talus, and a small splashing at the southeast cone. There was a collapse of the floor on the north side of the pit, leaving what later developed into a rising crag between the main lake and the northern floor. On the fifth and sixth spurts and flows of lava came out of the west cones and a cone 50 feet up on the southwest talus. The flow from the west cones on the sixth covered the whole southwest border of the floor, 500 feet in length. In the main lake, a torrent was pouring from the east arm into the main pool. On December 7 a further collapse of the floor area on the north produced a trench between the east arm and the northwest pond, the floor block between this trench and the lake being raised and tilted toward the lake to produce what will be called the "crag." A slight drop in the level of the lake the next day showed a promontory between the crag and the east arm, almost cutting off the latter. By December 9, the crag had risen on the north side 58 feet above the

lake level, which was 446 feet. The length of the lake was 435 feet, the floor 750 feet.

Until the thirteenth, little change took place in the lake. The fountaining was active, especially at Old Faithful, the streaming normally active with sudden reversals of direction, and splashing caves. On the twelfth and thirteenth, new flows spread south and north from the west cones, and the old floor had tilted downward on the west, indicating that the floor which fills the Halemaumau pit is subject to differential tilting movements from loading or unloading, irrespective of the relative stability of the walls of the pit. For the first time in 1914, the main lake overflowed, the flows moving southward.

From December 18 to 22, at the time of the winter solstice, a rise took place in the lake. The rise started with tremendous flows pouring from the northwest pond north and south, reaching the main lake on the north at the east arm, on the south at the southwest. With these flows, the crag and the west cones rose like islands. The rate of flow was, at the source, one half to one mile an hour, and the duration of the flow nineteen hours. On the succeeding days there were similar flows, always coming either from the northwest pond or from the cones. In the lake, meantime, the currents from the east met smaller ones from the west in the vicinity of Old Faithful, causing violent fountaining. With the sudden rises there was frequently a diminution in the fountaining, the east arm and northwest pond skimming over.

The flows occasionally ran into caverns or ovens on the southern floor. In the case of one of the ovens, blobs of molten lava were thrown to a height of 50 feet as the torrent poured in. The crag rose with the flooding of the floor and with the rise in the lake, until on December 28 it was 47 feet above the lake.

On the twenty-eighth a flow poured around the north side of the crag and overwhelmed the east arm. Above this arm there was an open lava tube, about 10 feet in diameter, which had been exposed for several months. Into this tube, on the northeast wall of Halemaumau, the flow ran, with a crackling noise, for thirty hours or more, forming a pseudo-intrusive body. The flow was in the form of a cascade, with a ten-mile-an-hour current. Two days later the frozen cascade was covered by another flow. About March 1, 1915, a slide uncovered the filled entrance to the tube.

The closing days of the year were marked by new flows from the main lake as well as from the cones and the northwest pond. Several flows from the latter cascaded directly into the main lake at the west end, when the level of the lake was 10 feet below the rim. New Year's Eve witnessed jets of lava spurting to a height of 100 feet from the top of a cone on the southwest floor. The southeast cove of main lake was divided in two parts by a projecting lump of spatter. The northern portion was a seething cauldron into which lava poured with incessant fountaining, the cauldron maintaining a level two to three feet lower than the main lake. The southern portion of the cove was normally full of lava to the level of the main lake.

The maximum activity was attained during the first few days of January, 1915. On the second the lake had attained a level of 368 feet, and was one foot below the bank. On the following day the northwest pond had increased in size and a west pond had developed. The southeast cove had lost its partition and resumed its normal activity. The fumes on this and the preceding day were less dense than at any other time in the period of activity.

The relative movement of the lake and crag on the north are noteworthy. On December 9 and 23, the crag was 58 feet above the lake although the lake had risen 41 feet. On January 2, the lake had risen 12 feet more, but the crag had subsided 12 feet as it was only 23 feet above the lake.

Indications of slow subsidence were noted after January 4, in the increasing fume cloud, falling lava, enlargement of the ponds, and scarcity of new flows. On the 5th there were new flows on the floor from the south and southeast coves, and a definite pond had formed southwest. This additional pond made the third in a semicircle at the west side of the pit, each being about 100 feet long and oval in

shape. During the day the southwest and west ponds filled up and overflowed, but the main lake remained about 4 feet below its banks. The streaming was from east to west, with fountains bursting to a height of 40 feet at Old Faithful. The level of the lake on January 6 was 368 feet, and about 10 feet below its walls. The southwest pond had become an oval pit 20 feet deep with a sunken black crust for a floor. Molten lava poured over one corner of the floor and a fountain played in another. The west pond was crusted over. The northwest pond was active.

With the subsidence on January 7–8, the floor began to crack. The following day the lake was 15 feet below the floor and a large crack had developed near the southwest shore of the lake. In the east pot, a continuation of the southeast cove, the lava was streaming southeast. The southwest pond remained a pit; the west pond had a dim glow; and the northwest pond remained active. On the 11th, there was a small flow southwestward from the west pond. The next day there were evidences of subsidence in the enlarging of the pool, by inbreak on the north end of the east arm; in slides; in blowing noises; greater fountain activity and streaming. The lake was 495 feet long, the east arm 250 feet long from its entrance, the depth 391 feet, with an inner wall 28 feet high.

On January 13 the east pot collapsed. The southwest and west ponds were deep pits, the latter smoking, but the northwest pond remained active. The streaming on the 13th and 14th was from the east toward the west. Rock slides took place on the 15th and 16th. On the 18th the bridge between the southeast cove and the east pot collapsed. There was a torrential inpouring, for a time, at the north end of the east arm. Later there was a sudden rise of 5 feet with a flow toward the west, and a green-blue flame 5 feet high; followed in 15 minutes by a subsidence of 5 feet. The sinking continued on the 19th with intense fountaining, streaming from the east arm, and rock slides. On the 20th, lava cascaded into the lake from an orifice 8 feet above the lake level on the west side. The direction of streaming reversed suddenly several times, with sudden small changes in level of the lake.

Whirlpooling began on January 23, with a whirlpool in the south cove, 100 feet in diameter and a very rapid rotation counter-clockwise accompanied by a roaring noise. Torrents were pouring from the east arm. The northwest pond was active, but the other ponds had ceased activity. The lake was 515 feet long, 160 feet wide, 440 feet below the rim; the east arm was 420 feet long. The crag had become flatter, sinking toward its original position.

After a temporary rise on the 24th, and another on the 27th, the lake was 436 feet below the rim and the crag 376 feet on the 30th. Caving took place on the north edge of the lake, and on the next day at the east end of the southeast cove. The southwest part of the old floor subsided.

Whirlpools were formed February 2–4, but in neither case was the motion so rapid or so violent or was there such a convexity to the stream as on January 23. On each of the three days in February a torrent poured from the east arm or out of the southwest cove, at a rate of 10 to 15 miles an hour, and developed a powerful vortex near Old Faithful with a clockwise rotation. Through the convex stream, bubble fountains burst incessantly. Back eddies were occasionally developed in the south cove and at the west end.

Slow subsidence continued during February, with the formation of concentric benches by subsidence of portions of the 1914 floor, and with active gas escape and fountaining, which indicates a concentrated escape of the gas and active convection. On the 11th, a new 1915 bench was built by a temporary rise. The west pit had become continuous with the northwest, and later it became joined by a trench with the east arm, which froze over by the 18th, and ceased to be a part of the lake. By the latter date, a depression had developed across the south side of the pit. New smoke holes had developed in a number of places, and these, together with fumaroles on the south side, make seeing difficult. The northwest pond had crusted over and temporarily ceased activity.

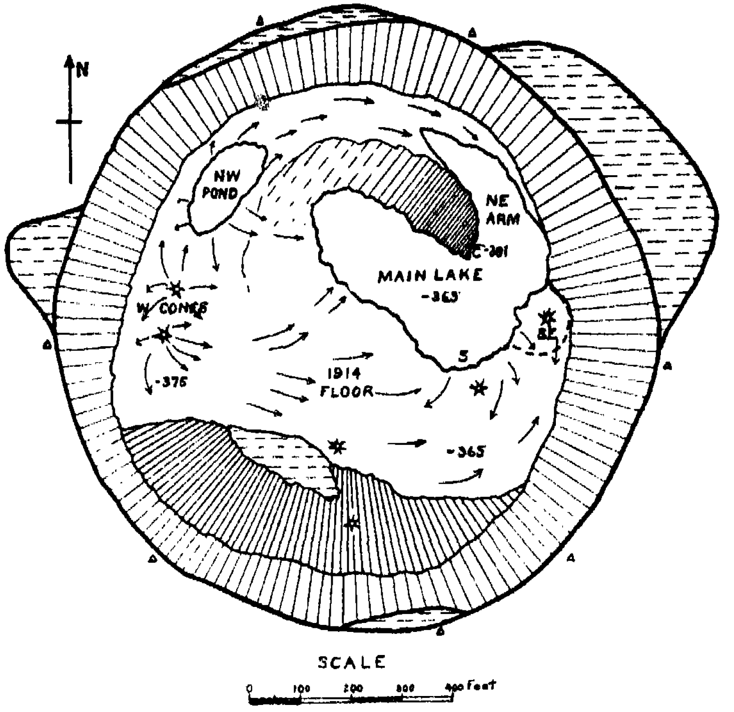


FIG. 1. The lava lake in the pit of the crater Halemaumau, at the time of the maximum activity about January 4, 1915. The main lake and the northwest pond, especially the west cones and pots, were the sources of the lava flows which built up the 1914 floor. The west and southwest cones developed into ponds, and the southeast cone (SE.) into an arm to the main lake like the south arm (S.). Between the northeast (or east) arm and the main lake is the crag which rose and sank with the lake, as a counterbalance to the flooding of the floor as indicated by arrows. South of the floor is a talus slope with a fragment of a ledge at the base. Around the rim of the pit are remnants of the 1911–12 floor and of 1894 cave-ins.

During the last of February, the lava remained at a level of about 460 feet below the rim, with daily variations, and especially rises at noon and midnight, of 2 to 20 feet. Fountains were very active in the Old Faithful region, and the streaming was variable, and often rapid. At the sides of the lake caves would splash, and the lava run in as long as the gas explosions continued. Some of the caves remained active for five minutes or less, others for hours. Migrating fountains were active, and frequently a fountain area near the center of the lake, into which lava was streaming, would suddenly move to one side of the lake and form a splashing cave.

On February 23 and 24, the lake rose to within a foot or two of the 1915 small floor on the south side. The following day the lava flooded the lower floor at noon and at night, with fountains spraying 50 to 80 feet high. The streaming was from the northeast toward the west and less actively toward the southeast. Four new driblet cones appeared in the western trench at the site of the pots and cones from which the flows came at the close of 1914. On the 27th, Old Faithful was playing at intervals of 10–20 and 50–60 seconds. On the 28th, a sudden rise at noon flooded the lower floor.

A small arm to the lake on the southeast developed by March 1, and the following morning a clockwise vortex developed in it, with an inrush at a rate of 8 miles an hour into the east side, the lava pouring out of the

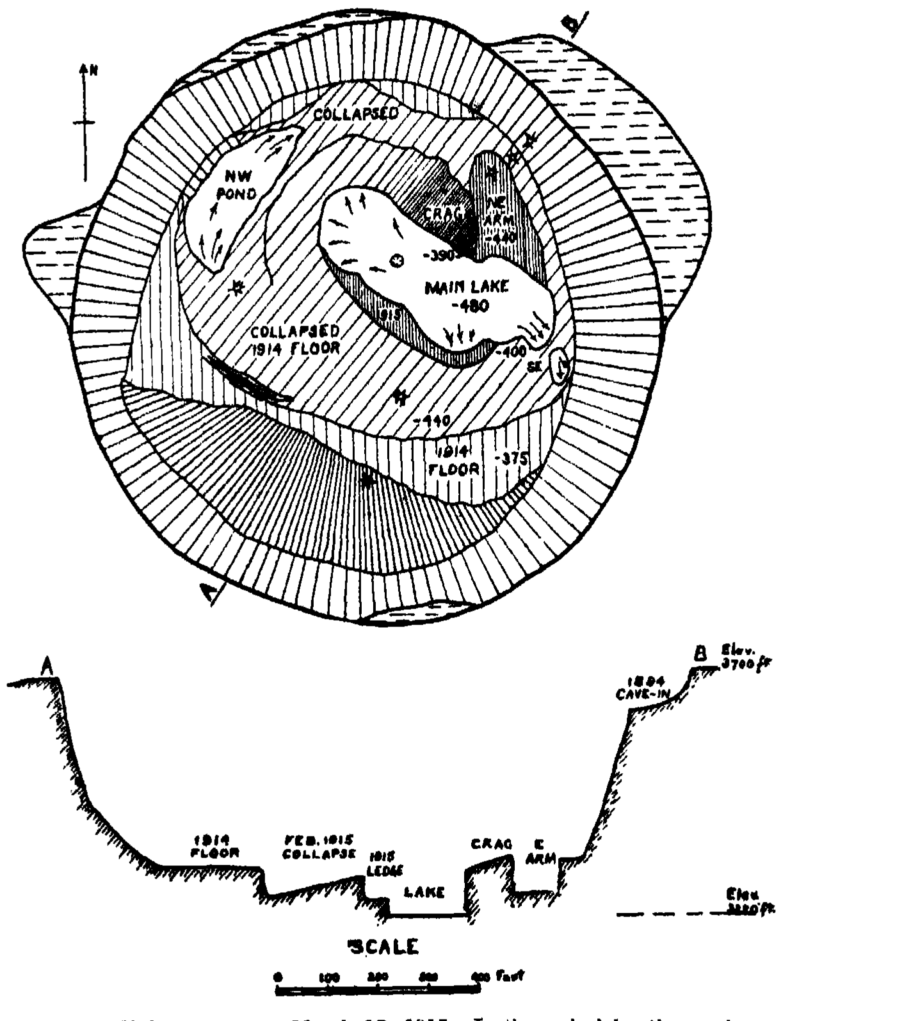


Fig. 2. The pit of Halemaumau on March 15, 1915. In the main lake, the northwest pond, and a small southeast pond (SE.), the general directions of the currents in the lava are shown by arrows. The collapsed 1914 floor is greatly fissured and broken up into blocks which can not be represented here. The cross-section A–B shows the remnants of the 1914 floor. The elevations given are above sea-level; the depths are below the rim.

southeast end and from the main lake. This rush lasted for an hour, and at noon the lake became quiet, indicating a rise. On the 3d, the lava streamed from the middle, both east and west, and a torrent poured into the southeast arm which maintained a level several feet below the lake.

The activity in March in the main lake has been very much as during the last of February. Portions of the lake have been frozen at times, especially the east-central portion, only to break up suddenly, when a fountain developed at the side of the lake, and the crusts streamed toward the fountain. On several days lines of fountains have been observed toward which crusts were drawn, and sometimes the whole line migrated to the margin of the lake to form a spatter-fountain. The most persistent

of the splashing caves have been on the west and south sides, with streaming in these directions.

The northwest pool appeared on March 7, owing to a collapse of a portion of the crust on which there had been spatter cones. The pool was 25 $\times$ 40 feet. The next day the pond was larger, and on the 9th still larger. Southeast of the pool there was a small orifice throwing drops of molten lava 70 feet in the air. The lava in this orifice was several feet lower than the level of the pond, although but a few feet away. The pool was fountaining quietly until the crust suddenly broke up and was swept in the north end. On the 15th, this pond had increased in size until it was 270 feet long (north-south), and 100 feet wide. All the fumaroles had collapsed into the pond. The pool was quiet with three splashing caves until suddenly a violent streaming from the south end to the northeast end developed, and three minutes later the 1914 shelf above the place of inflow collapsed. The north end of the pond was filled with talus, and the remainder became quiet.

The main lake on March 15 was found to have increased in size by a collapse, on the south side, of a crescentic area 150 feet long and 30 feet wide in the center. The length of the lake from northwest to southeast was 500 feet, the width at the center 150 feet, the depth 480 feet—35 feet below the 1915 ledge. On the southeast, a small pond had developed by the appearance of a ledge across the southeast arm of the lake. This pond was splashing violently. The next day the lava from the main lake was pouring into it under a natural bridge, and rushing at a rate of 6 miles an hour under the 1914 shelf on the south. On the 19th, this current was still rushing into the small pond, and the level of the lake had dropped. The northwest pond had also dropped, leaving a circular shelf and a black ledge.

Mauna Loa broke out, with great lava fountains in the crater Mokuaweoweo, between noon and one o'clock on November 25, 1914, as described by Professor T. A. Jaggar, Jr.[2] On the 28th, the party which reached the summit observed a long fountaining pool on the south side of the Mokuaweoweo basin, with overflows on the floor. There were eight main fountains and a sheet fountain on the south, playing continuously to heights of 300 to 400 feet. On December 4, only four fountains were seen, the northernmost being the larger.

The fume column on the first night was of the pine-tree form, being composed of from 4 to 6 wavy strands. On the second night the column was estimated by Mr. H. O. Wood to have a height of 6,000 to 7,000 feet. On the first of December, a slender, straight fume column was seen, faintly illuminated, and rising to a height of 9,000 feet or more. From December 7 until the evening of the 10th, no trace of a fume column was seen from Kilauea. An evening glow and fume cloud, and occasionally fumes by day, were visible on clear days during the remainder of December, and until January 11, when both glow and fume cloud disappeared together. The greatest fume column in December was after Christmas, and the final diminution in volume occurred during the last week.

The Volcano Observatory expedition reached the summit on December 15. In the southwest part of the crater a large red fountain was playing continually to a height of 100 feet and occasionally to a height of 150 feet. The fountain was at the northeast corner of a pool of crusted pumiceous lava, and in front of a portion of a cone 75 feet high of its own construction. On the west side of the lake there were lower fountains, and still other fountains broke through the crust of the pool at different times. The character of the fountains, with jets forming fragments which floated away, suggested a very gaseous, light liquid. No changes in the walls or pits of Mokuaweoweo were observed.

The activity of these volcanoes in the immediate future is difficult to predict because of the scarcity of detailed information concerning them previous to 1911. A general response of the lava to earth tides has already been shown by Mr. F. A. Perret, and the summary given above shows that the lava in Kilauea

[2] *Amer. Jour. Sci.*, Vol. 39, 1915, pp. 167–172.

tends to rise at solsticial times, and to sink at the time of the equinoxes. Mauna Loa responded to the last solstice with an outbreak. In Kilauea a daily rise at noon and midnight has been observed at almost all the prolonged watches during the past month. There has also been a periodic activity of Mauna Loa, and a certain amount of periodicity in Kilauea.

At the time of the 1907 activity of Mauna Loa there was a period of relative inactivity in Kilauea. Since that time there has been prolonged activity. If the next quiescence is to come in the near future, as is perhaps foreshadowed by the dropping of the lava in 1913–14, the lava may continue to drop after the coming equinox, and disappear. If, on the other hand, the present period of activity is to continue, the lake will rise during the spring in response to the summer solstice.

Mauna Loa, since the first known eruption in 1832, has shown an average duration of epochs of 11.5 years before 1868, and 5.5 years since 1868; with an average interval of repose before 1868 of 5.5 years, and since 1868 of 4.75 years. The maximum intervals of repose have been eight years each, the second being the last one. Moreover, the general activity has been an outbreak on the summit, followed, sooner or later, by an outbreak on the side of the mountain accompanied by a lava flow. Within the next three or four years, at one of the solsticial times, there should be another flow.

Sidney Powers

Hawaiian Volcano Observatory,
March 19, 1915

INTERSTATE CEREAL CONFERENCE

An Interstate Cereal Conference was held at the University of California, Berkeley, June 2, 1915, with an attendance of 37. Dr. J. W. Gilmore, of the University of California, was elected chairman and Mr. Charles E. Chambliss, of the U. S. Department of Agriculture, secretary. The executive committee consists of the officers and Messrs. M. A. Carleton, F. S. Harris and Bert D. Ingels. The program was as follows:

"Cereal Production in California as Affected by Geographic and Climatologic Conditions," by J. W. Gilmore and B. A. Madson.

"The Water Requirements of Cereals as determined by Physical Environments," by H. L. Shantz and L. J. Briggs.

"Work with Cereals at the Nevada Experiment Station," by C. S. Knight.

"Effect of Various Alkali Salts on the Growth of Cereals," by F. S. Harris.

"Improvement of Barley for the Pacific Coast," by E. Clemens Horst.

"Possible Sources of Barley for Introduction into California," by H. V. Harlan.

"Present Status of Studies of *Helminthosporium* Diseases of Barley in America," by A. G. Johnson.

"*Rhyncosporium graminicola* on Barley," by James McMurphy.

"Cereal Diseases and their Control in Denmark," by F. Kølpin Ravn.

"Wheat Varieties of the Basin and Pacific Coast States," by C. R. Ball.

"The Bunt Problem in the Pacific Coast States," by H. B. Humphrey.

"Wheat Breeding in the Rocky Mountain Regions," by B. C. Buffum.

"The Effect of Rust on Water Requirement of Wheat at Akron, Colo.," by H. L. Shantz and L. J. Briggs.

"The Milling of California Wheat," by B. D. Ingels.

"Commercial Handling and Grading of Grain," by L. M. Jeffers.

On June 1 the cereal crops in the vicinity of Stockton, Cal., were inspected by many in attendance at the conference.

The cereal experiments of the University of California at Davis and of the office of cereal investigations, U. S. Department of Agriculture, at Chico and Biggs, Cal., were inspected June 3 and 4.

Charles E. Chambliss,
Secretary

INVENTION COMMITTEES IN ENGLAND AND IN THE UNITED STATES

The Invention Board established by the British government consists of a central committee and consultants who will advise the main committee on questions referred to them.

The central committee is composed of Admiral Fisher, chairman, Sir Joseph John Thomson, Cavendish professor of experimental physics at Cambridge University; Sir Charles A. Parsons, and Mr. George T. Beilby, chairman of the Royal Technical College at Glasgow. The consulting panel includes the following and will be added to from time to time as such action becomes necessary: Herbert B. Baker, professor of chemistry at the Imperial College of Science and Technology, London; William H. Bragg, Cavendish professor of physics, University of Leeds; H. G. H. Carpenter, professor of metallurgy in the Royal School of Mines; Percy F. Frankland, professor of chemistry and dean of the faculty of science, University of Birmingham; Bertram Hopkinson, professor of mechanism and applied mechanics, Cambridge University; William Jackson Pope, professor of chemistry, Cambridge University; the Hon. Robert J. Strutt, professor of physics, Imperial College of Science; Sir William Crookes, the well-known chemist; Mr. William Duddell, electrical engineer; Sir Oliver J. Lodge, principal of the University of Birmingham; Sir Ernest Rutherford, professor of physics, University of Manchester, and Mr. George Gerald Stoney, a consulting engineer.

Secretary Daniels announced on July 19 that he had that day written to eight leading scientific societies asking each of them to select two members to serve on the proposed Naval Advisory Committee on inventions, of which Mr. Thomas A. Edison has accepted the chairmanship. The societies are: American Chemical Society, President Charles H. Herty; American Institute of Electrical Engineers, President Paul M. Lincoln; American Institute of Mining Engineers (metals), President Benjamin B. Thayer; American Mathematical Society, President E. W. Brown; American Society of Civil Engineers, President Hunter MacDonald; American Society of Mechanical Engineers, President James Hartness; American Aeronautical Society, Acting President Frederick W. Baker, and the Inventors' Guild, President Dr. Edward Weston.

The New York *Times* states that "when the attention of Secretary Daniels was called to the fact that he had not invited the American Association for the Advancement of Science or the National Academy of Sciences to participate in the naming of the board, Mr. Daniels answered that it was not his purpose to overlook any of the leading scientific bodies and that it was altogether possible that additional invitations might be sent to several other societies. The American Association for the Advancement of Science was organized in 1848 and now has a membership of 8,100. The National Academy of Sciences, incorporated by Act of Congress on March 3, 1863, is composed of 139 members and 49 foreign associates. The act of congress provides that the academy 'shall, whenever called upon by any department of the government, investigate, examine, experiment and report upon any subject of science or art, the actual expense to be paid from appropriations which may be made for the purpose.'"

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM H. WELCH, professor of pathology in the Johns Hopkins University, sailed for China on July 17, and Dr. Simon Flexner, director of the laboratories of the Rockefeller Institute for Medical Research, will join him there. They go on behalf of the China Medical Board of the Rockefeller Foundation to report on the medical schools and hospitals.

A MARBLE chair is about to be placed in the open-air Greek Theater of the University of California in honor of Eugene Waldemar Hilgard, professor of agriculture and dean of the College of Agriculture from 1875 to 1906, and now professor emeritus.

THE next course of Lane medical lectures before the School of Medicine of Stanford University, will be given by Dr. Frank Billings, of Chicago. Dr. Billings will speak on "Focal Infection." The five lectures will be delivered the evenings of the week of September 20 to September 25, 1915. Dr. Billings has also agreed to give some clinical demonstrations.

PRINCE BORIS GALITZIN, professor of physics in the Imperial Academy of Sciences, Petro-

grad, has been appointed Halley lecturer for the year 1916 at the University of Oxford.

Dr. George E. De Schweinitz, of Philadelphia, was elected president of the American Ophthalmological Society at the annual meeting held recently in New London, Connecticut.

The council of the Royal Society of Edinburgh has awarded the Makdougall-Brisbane prize for the biennial period 1912–14 to Professor C. R. Marshal, Dundee and St. Andrews, for his studies on pharmacological action of tetra-alkyl ammonium compounds.

The Physikalisch-Medizinische Gesellschaft at Würzburg, the local scientific society to which Röntgen presented his first report on the Röntgen rays, has recently had his three communications on the subject reprinted in pamphlet form.

As has been noted in Science the Osiris prize of $20,000 was recently awarded for antityphoid vaccination to Professor Vincent and Professors Chantemesse and Widal. We learn from the *Journal* of the American Medical Association that Dr. Chantemesse has devoted his share to the preparation and gratuitous distribution of antityphoid vaccine in France. Dr. Widal has presented his share to the Assistance publique as a contribution to the construction and the maintenance of the laboratory of the Cochin Hospital.

The University of Leeds, as we learn from *Nature*, conferred on July 8 honorary degrees as follows: *Doctor of Science:* Mr. Harold W. T. Wager, F.R.S., inspector of schools, who began his professorial career at the Yorkshire College, known for his researches in cytology and other biological fields. *Master of Science:* Mr. T. H. Nelson, of Redcar, author of "The Birds of Yorkshire"; Mr. W. Denison Roebuck, joint author of "Handbook of the Vertebrate Fauna of Yorkshire"; Mr. T. Sheppard, curator of the Hull Museums, author of "Geological Rambles in East Yorkshire," "The Lost Towns of the Yorkshire Coast," and many geological and archeological memoirs; Mr. J. W. Taylor, author of a "Monograph of the British Land and Freshwater Mollusca"; Mr. J. G. Wilkinson, past-president of the Leeds Naturalists' Club, distinguished by his extensive and exact knowledge of the structure of plants, though blind; Dr. T. W. Woodhead, lecturer in biology at the Technical College, Huddersfield, honorary secretary of the Yorkshire Naturalists' Union, and author of various biological memoirs.

Dr. Alfred Schultze has been promoted to be professor and member of the Reichsanstalt, at Charlottenburg, and Dr. Walther Meissner to be an associate in the institution.

A laboratory of the U. S. Public Health Service for the investigation of occupational diseases is to be established in Pittsburgh under the supervision of Dr. J. W. Schereschewsky, of Washington.

Professor H. S. Jackson, head of the botany and plant pathology department of the Oregon Agricultural College, has resigned to become chief of the botany department of the Purdue University Experiment Stations.

Dr. Henry S. Graves, chief of the U. S. Forestry Service, has gone to Alaska to inspect the Alaskan forest reserves.

Drs. Harry Plotz and George G. Bohrer, both of the staff of Mt. Sinai Hospital, New York, have sailed on the Greek steamer *Themistocles.* They took with them a complete bacteriologic outfit supplied by the hospital and will proceed to Nish where they will join Dr. Richard P. Strong, the head of the Serbian sanitary commission.

Joseph B. Umpleby, of the U. S. Geological Survey, will spend the year 1915–16 at the University of California as acting professor of geology, serving in the stead of Professor George D. Louderback, who is to spend a second year in China investigating the oil deposits of China in behalf of the Standard Oil Company.

Professor Lyman C. Newell, head of the department of chemistry in Boston University, has returned from his sabbatical year and will resume his teaching upon the opening of the university in September.

Dr. Joseph Austin Holmes, director of the U. S. Bureau of Mines since its establishment

in 1910, previously chief of the technological branch of the U. S. Geological Survey, professor of geology in the University of North Carolina and state geologist of North Carolina, died from tuberculosis in Denver, Colorado, on July 13, in his fifty-sixth year.

DR. FRANCIS DELAFIELD, the distinguished New York physician and pathologist, professor emeritus of pathology and the practise of medicine in the College of Physicians and Surgeons, Columbia University, died on July 18, at the age of seventy-four years.

DR. ROBERT MACKAY DAWBARN, professor of surgery at the Fordham University Medical School, senior surgeon of the New York Hospital, died on July 17, in his sixty-sixth year.

CHIEF ENGINEER JOHN J. BISSETT, United States navy, retired, died at Bridgeport, Conn., on July 20, aged seventy-nine years.

MR. ROBERT HEATH LOCK, known for his work in genetics, formerly curator at the University of Cambridge and assistant director of the Botanic Gardens of Peradeniya in Ceylon, has died at the age of thirty-six years.

MR. C. E. P. SPAGNOLETTI, the British electrical engineer, died on June 28, at the age of eighty-three years.

PROFESSOR HUGO LUTHJE, director of the medical clinic at the University of Kiel, has died at the age of forty-five years.

PROFESSOR FRITZ MÜHLBERG, the Swiss geologist and paleontologist, has died in Aarau.

DR. MAX RAPPART, assistant in chemistry under Professor Fischer in the University of Berlin, has been killed in the war.

WITH the issue of the *Athenæum* for July 3 is published the first instalment of a subject index to periodicals, undertaken at the request of a committee appointed for the purpose by the Library Association. The progress of science and technology in 1915, with special reference to the war, is the first subject to be indexed.

FOR the survey of the animal and bird life of the Yosemite National Park, being carried on this summer by the California Museum of Vertebrate Zoology, a gift of $1,145 has been made to the University of California by Miss Annie M. Alexander, of Oakland, Senator Joseph D. Phelan, of San Francisco, Mr. G. M. Marston and Mr. Stephen T. Mather, assistant secretary of the interior.

THE United States Geological Survey has issued a guidebook describing the overland route from Missouri River to the Pacific coast. It is Secretary Lane's desire that the transcontinental journey, by whatever route, shall afford the traveler an intimate acquaintance with the country through which he passes, and this volume, therefore, is the first of four which will appear in rapid succession. The next to come, that covering the Northern Pacific route, so closely identified with the Lewis and Clark expedition of 1803–06, will be published in a few days; and those describing the Santa Fe route and the Shasta and Coast route will follow soon. The route is followed from station to station, and the country along the way described and explained from many points of view—human history, geologic history, agricultural and mining values. The guide books are full of items of general interest that will answer such questions as the average intelligent traveler is continually asking. In a broad way the story of the west is a unit, and the aim of this description of the western United States is to meet the needs of the American citizen who desires to understand what he sees. In the preparation of the book on the Overland Route (Bulletin 612) much information already in the possession of the Geological Survey has been utilized, but to supplement this material three geologists last year made a field examination of the entire route, while special topographic surveys for the accompanying maps were made by survey engineers. The route is covered by a series of 29 complete and accurate maps, which are so arranged that the reader can unfold them one by one and keep each map in view while he is reading the text relating to the portion of the route it represents. The book is also freely illustrated with half-tone plates of some of the most striking views and objects to be seen on the journey and with pictures of prehistoric animals that inhabited the west in ages past,

when Nebraska and Colorado, for instance, were huge swamps frequented by strange beasts whose fossil remains are now found in the rocks formed from the sand and mud of the ancient swamps, which have since been elevated thousands of feet. The book of 244 pages is as a whole distinctly popular in character.

UNIVERSITY AND EDUCATIONAL NEWS

GOVERNOR DUNNE has signed the bill giving $5,000,000 to the University of Illinois for the biennium. It is the largest grant made in a single law to any university in the United States.

THE University of California has accepted an offer of the Children's Hospital, of San Francisco, whereby the hospital remains independent financially and administratively, but whereby all its resources become available for the educational purposes of the University of California Medical School.

A SEPARATE department of chemical engineering on the same plane as the mining, civil, electrical and mechanical engineering departments will be established in the Columbia graduate engineering school next fall. The head of this department will be Professor Milton C. Whitaker, who has been the professor of engineering chemistry for the past five years. For the past ten years the university has offered courses leading to the degree of chemical engineer in the department of chemistry but the rapidly increasing importance of these industries based upon the applications of chemistry and the subsequent demand for men especially trained in fundamental engineering problems has led the university to supplement these courses with the more elaborate facilities and opportunities offered in a separate chemical engineering department.

THE new announcement of the West Virginia University states that on and after September 1, 1917, two years of collegiate work, including courses in physics, chemistry, biology and French or German, will be required for admission to the medical school.

THE University of Cincinnati is again giving a pre-medical summer course in physics, analytical chemistry, organic chemistry and zoology. The term lasts from June 7 to August 14, a period of ten weeks.

DR. M. ALLEN STARR has resigned the professorship of neurology at the College of Physicians and Surgeons, Columbia University, and has been succeeded by Dr. Frederick Tilney, Brooklyn.

DR. R. H. GODDARD, instructor in physics at Clark College for the past year, has been made assistant professor.

THE following appointments have been made in the medical faculty of McGill University: Assistant professor of chemistry, Dr. F. W. Skirrow; assistant professor of physiology, Dr. J. A. Gray; associate professor in pathology, Dr. Horst Oertel; assistant lecturer in physiology, Dr. T. P. Shaw; lecturers in immunology, Drs. J. C. Meakins and Fraser B. Gurd; lecturer in hygiene, Dr. R. St. J. Macdonald; lecturer in biology, Dr. F. S. Jackson, and associate professor of physics, Dr. L. V. King.

DR. RICHARD HEYMONS has been appointed professor of zoology in the Berlin School of Agriculture.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL EQUATION OF MECHANICS

I. IN regard to the question whether $F = ma$ or $F/F' = a/a'$ is the better form in which to introduce the fundamental equation of mechanics, the first point of difference between Professor Hoskins and myself may be stated as follows:[1]

Professor Hoskins's method presupposes, as a matter of common knowledge (in advance of any statement of the fundamental equation), the difficult concept of mass or inertia; while my method postpones the introduction of this concept until the student is in position to define it intelligently in terms of the simpler concepts of force and acceleration.

In an attempt to justify his introduction "at the outset" of the "body-constant," mass,

[1] See Professor Hoskins's article in SCIENCE for April 23, 1915, which was written in reply to an article of mine in SCIENCE for February 5, 1915.

which he dissociates altogether from weight, Professor Hoskins makes use of the time-honored device of defining mass as "quantity of matter." He holds that

the definition (of mass as quantity of matter) has a sufficiently definite meaning, gained from ordinary experience, to be of service in a preliminary explanation of the laws of motion.

This, however, has not always been his opinion. In his excellent treatise on "Theoretical Mechanics,"[2] on page 2, he says:

The mass of a body is often briefly defined as its "quantity of matter." These words, however, convey no definite idea of the meaning of mass as a factor in the determination of motion. A satisfactory definition of mass can not be given in advance of a discussion of the fundamental laws of motion.

This earlier view of Professor Hoskins is precisely the position which I wish to defend. For mass, as a factor in the determination of motion, means the constant ratio of force to acceleration (for example, the statement: "body *A* has three times the mass of body *B*" is precisely equivalent to the statement: "body *A* requires three times as much force as body *B* to give it a specified acceleration"); and whatever idea the words "quantity of matter" may convey to a beginner's mind, they certainly can not convey this desired idea of mass or inertia until *after* the ideas of force and acceleration, and the idea of the constancy of their ratio for a given body, have been grasped.

Why has Professor Hoskins abandoned this excellent position? The only argument which he advances in favor of the definition of mass as quantity of matter is expressed as follows:

In comparing the masses of bodies composed of one homogeneous substance, the significance of the words "quantity of matter" is indeed readily recognized, and it is distinctly helpful to generalize this notion.

But when one tries to analyze this argument, one runs at once into difficulty. What is the concept which Professor Hoskins here proposes to generalize? In the comparison of bodies composed of one homogeneous substance, the thing that strikes one as most obvious is that doubling the "quantity of matter" in a body is equivalent to doubling its volume or bulk. Two bricks, we say, contain twice as much clay as one brick. Are we then to understand that it is the notion of *bulk,* which, when properly "generalized," is to lead us to the notion of *mass?*

This can hardly be the interpretation which Professor Hoskins intends. It is true that the notion of bulk is sufficiently familiar, and it is also true that in the case of a homogeneous substance, the mass of a body happens to be proportional to its bulk; but it is surely not true that any correct idea of mass as a factor in the determination of motion can ever be obtained by generalizing the idea of bulk.

What then are we to understand by Professor Hoskins's appeal to the case of homogeneous substance? How does this appeal advance us toward the conception of mass as a factor in the determination of motion? Professor Hoskins's article gives no answer to this question, and I believe that no answer can be given—that in fact the whole attempt to define mass or inertia as "quantity of matter" is utterly vague and futile.

There are, of course, certain contexts in which the term "quantity of matter" is useful. For example, if we start a bonfire in a hermetically sealed box, we may properly say that the "quantity of matter" in the box is the same before and after (for the simple reason that we suppose nothing to have been added and nothing to have escaped). But this tells us merely that for dynamical purposes we may properly treat the contents of the box as *one body,* in spite of any change in size, shape or chemical constitution. It does not tell us anything about the mass of this body. For the mere fact that the quantity of matter in the body is invariable (and this is the only fact about its "body-constant" which can properly be presupposed in advance of some study of inertia) gives us no information whatever about the motion of the body when acted on by a force. Not until we have ascertained by some physical experiment what acceleration is produced in the body (or in some

[2] Second edition, 1903.

equivalent body) by some known force can we predict what acceleration will be produced in the body by any other force. In other words, not until we have applied in some form or other the principle expressed by the equation $F/F' = a/a'$ can we arrive at any practical working knowledge of the mass or inertia of the body, as a factor in the determination of its motion. To say to the beginning student: "Here is a body whose mass is so and so much" simply begs the question, unless he understands how this datum was obtained. The mass or inertia of a body is like its modulus of elasticity; it is physical property to be discovered by experiment, not a metaphysical something to be presupposed as a matter of common knowledge.

In view of those considerations, I can not agree with Professor Hoskins when he says there is no reason for regarding the equation $F/F' = a/a'$ as more "fundamental" than the various other equations mentioned in his paper. The reason seems to me very obvious. The statement of this equation presupposes on the part of the reader a knowledge of the meaning of only three fundamental terms, namely: *body, force* and *acceleration;* while the statements of the other equations presuppose a knowledge not only of these three terms, but also of a fourth term, *mass*. Since the notion of *body* is obviously more elementary than the notion of *body-having-a-given-mass*, the equation $F/F' = a/a'$, which involves only body and not mass, seems to me clearly more fundamental than any of the other equations, and (especially in the form $F/W = a/g$) much more suitable as an introduction to mechanics.

II. A second point of difference between Professor Hoskins and myself concerns the questions of units. According to my method, any units one pleases may be chosen for force, length, and time, and all the other quantities which occur in elementary mechanics are then expressed systematically and naturally in terms of these fundamental units. Hence, as soon as the student has grasped the meaning of the fundamental equation $F/F' = a/a'$, he can proceed at once to the solution of practical problems.[4] On the other method, the student is unable to begin work on the simplest problems in rectilinear motion (such as those treated on page 186 of Professor Hoskins's "Theoretical Mechanics") until after he has mastered a long discussion of various artificially restricted systems of units, with their unfamiliar names like the dyne and the poundal (pages 177–186). This needless restriction on the choice of units is a serious disadvantage to the beginner—a disadvantage which results solely from the insistence on the use of the equation $F = ma$ as the fundamental equation of mechanics, and which disappears altogether when the equation $F/F' = a/a'$ is employed.

In further defense of my contention that the system of units based on *force*, length, and time is more convenient and more natural than the system based on *mass*, length, and time, I may add that this contention is strikingly borne out by the usages of scientific terminology. Even in the C. G. S. system, which is understood to be based on the centimeter, the gram mass, and the second as the fundamental units, the dyne force plays a more important rôle in the naming of the derived units than does the gram mass. For example, the unit of power in this system is the dyne-centimeter per second; the unit of pressure the dyne per square centimeter, etc.; whereas if the gram mass were consistently retained as the fundamental unit, we should have to have 1 gram centimeter^2 per second^3 as the unit of power, and 1 gram per centimeter-second^2 as the unit of pressure! In other words, the awkward attempt to make mass the fundamental and force the derived unit has been practically abandoned in the accepted terminology of pure science. Why should it not be abandoned also in elementary teaching?[5]

[4] See my article in SCIENCE for February 5, 1915.

[5] We are not here concerned with the purely technical question as to how the physical standards for the various units may best be preserved to posterity. For purposes of elementary instruction, a standard spring balance representing a unit of force is just as satisfactory as a standard lump of metal representing a unit of mass, in spite

III. In regard to the equation $V = FTg/W$ which has been proposed by Mr. Kent in SCIENCE for March 19, 1915, my feeling agrees with that already expressed by Professor Hoskins in SCIENCE for May 7, 1915, namely, that no equation which covers only the special case of a body starting from rest, under a constant force, and does not involve the idea of mental equation of mechanics. Mr. Kent's paper, however, is not without interest on the pedagogical side.

IV. Finally, in regard to the objections raised by Professor Hoskins to a certain definition of the term "force of gravity" which I gave some years ago (objections which, it should be observed, do not affect the present question as to the choice of the fundamental equation of mechanics), I wish to say that his criticism seems to me well-founded, and that my definition was not happily phrased. The important facts about W and g remain true, however, as follows: If we define the weight, W, of a body, in a given locality, with respect to any given frame of reference, as the force required to support the body at rest with respect to that frame; and if we denote by g the acceleration of the body when allowed to fall freely in the given locality, as measured by an observer on the given frame of reference; then the ratio W/g will always be the correct expression for the mass or inertia of the body, regardless of any motion which the given frame of reference may possess. I hope to revert to this point on some future occasion.

EDWARD V. HUNTINGTON

HARVARD UNIVERSITY

THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

TO THE EDITOR OF SCIENCE: Please be so kind as to print in SCIENCE the following letter which I have addressed, under date of June 17, 1915, to Dr. Arthur L. Day, home secretary of the National Academy of Sciences, Washington, D. C.:

Replying to your request to subscribe to the *Proceedings of the National Academy*, may I voice of the fact that the latter is much more readily preserved than the former.

a protest which I believe many scientific men share with me, but which few will care to formulate and send to you.

A general scientific society, before which abstruse papers are read on most minute details of specialized scientific work, is an anachronism of the most glaring kind. Certainly, when a large audience endures patiently the reading and discussion of a paper which is entirely beyond the ken and comprehension of nine tenths of them, they are wasting their valuable time, and the whole procedure smacks of the farcical.

Further, when you publish such a miscellany of highly specialized papers in your *Proceedings*, is it fair to any man on earth to ask him to pay for the whole set of papers in order to get the one or two which he can read understandingly and profitably? You surely can not expect a man of understanding to risk acute mental indigestion by trying to assimilate the specialized articles entirely outside of his ability to absorb. Then why should any individual be expected to pay good money for so much material useless to him? Are you not guilty of wasting much good ink and paper, postage and shelf space—a waste which the apostles of true conservation should deplore and discourage?

Still further, modern efficiency in almost all its various shapes is based on pushing as far and as hard as possible in the contrary direction. Concentration of mind and effort towards one goal, elimination of the unnecessary and the distracting, doing one thing mighty well—are the principles of specialization which are at the basis of modern efficiency and achievement. But your society and its *Proceedings* tend towards diffuseness, cumber our minds and steal away our attention with the unnecessary and superfluous, and rob the special societies of papers and discussion which they alone are well fitted to receive and digest. In short, are you not a stumbling block before the wheels of scientific progress, a panderer to scientific charlatanism, rather than a promoter of scientific efficiency?

Let me in all seriousness recommend the abandonment of publication of your *Proceedings*, if not even the cancelling of your scientific sessions. Let the astronomers discuss "Photographic Determination of Stellar Parallaxes" with astronomers, the chemists "Chondrosamine" with organic chemists, the mathematicians "The Straight Lines on Modular Cubic Surfaces" with mathematicians, the zoologists "Ecology of the Murray Island Coral Reef" with zoologists, etc.—for only such special groups

of scientists can properly receive, understand and discuss such highly-specialized topics.

I am perfectly convinced, Mr. Secretary, that your complacent Pan-scientists would reject the recommendation *in parte et in toto*, but thinking men outside will agree that they should accept it, and be thankful!

JOS. W. RICHARDS

SCIENTIFIC BOOKS

Heredity and Environment in the Development of Men. By E. G. CONKLIN. Princeton University Press, 1915. Pp. xiv + 538, illustrated.

This book is based on a course of public lectures designed to present in non-technical terms a judicial view of eugenics as seen by a trained biologist. The author is particularly well qualified to undertake the task because of the breadth and depth of his biological knowledge, his own important contributions to several of the fields surveyed, his sound and well-balanced judgment, and his preeminent success as a teacher. He has succeeded remarkably well in a very difficult undertaking. For the lay reader can not fail to be interested in the wonderful array of post-Darwinian achievements in biology which are here marshalled in such a clear way; and the biologist familiar with the detailed discoveries to which mere reference is made by way of evidence or illustration, will profit much by the survey of a whole field in well-balanced perspective. The general reader, who gets from current literature quite contradictory and often distorted views as to the undertakings and the possibilities of the eugenics movement, will here find a correct and sane inventory of both.

The book is divided into six chapters, which deal with the following subjects:

I. Facts and factors of development. II. Cellular basis of heredity and development. III. Phenomena of inheritance. IV. Influence of environment. V. Control of heredity: Eugenics. VI. Genetics and ethics.

The conclusions reached in Chapter I. are concisely summed up thus: ". . . that every living thing in the world has come into existence by a process of development; that the entire human personality, mind as well as body, has thus arisen; and that the factors of development may be classified as intrinsic in the organization of the germ cells, and extrinsic as represented in environmental forces and conditions. The intrinsic factors are those which are commonly called heredity, and they direct and guide development in the main; the extrinsic or environmental factors furnish the conditions in which development takes place and modify, more or less, its course."

In dealing with the "cellular basis of heredity and development" (Chap. II.) the author is most at home, for this is the field of his own special investigations. He emphasizes the conclusions that the germ-cells are the exclusive basis of inheritance and probably of sex determination and that their structure is "almost incredibly complex."

In dealing with the "phenomena of inheritance" (Chap. III.) the author presents a careful digest of present-day and orthodox Mendelism, including the pure-line theory and the consequent ineffectiveness of selection, the theory that all inheritance is due to recombination of Mendelian factors, even when blending results are obtained, and that Mendelian factors are devoid of variability. The presentation is a remarkably lucid one, but one suspects that, had the author been as familiar with the phenomena of inheritance as with their cellular basis, he would not have been content to explain the former as relatively simple and clear-cut while declaring the latter "almost inconceivably complex." There is no ground for thinking inheritance phenomena less complex than their cellular basis, for which reason theories which call for "pure gametes" and "pure lines" are likely to be short lived.

Chapter IV. presents some of the more striking results from the experimental study of development.

Chapter V. contains the familiar argument for eugenics (human reproduction controlled with a view to biological improvement of the race), viz., the differentially declining birth-rate, involving the more rapid increase of the poorer strains of humanity, with the recommendation that reproduction of the socially unfit be limited and that of the socially supe-

SCIENCE

FRIDAY, AUGUST 6, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

EXPERIMENTAL AND CHEMICAL STUDIES OF THE BLOOD WITH AN APPEAL FOR MORE EXTENDED CHEMICAL TRAINING FOR THE BIOLOGICAL AND MEDICAL INVESTIGATOR. II

THE BLOOD AND THE SPECIFIC SECRETORY PRODUCTS OF THE ORGANS OF INTERNAL SECRETION

In this field we touch on the one hand upon knowledge which is deeply rooted in the earliest practical experience of mankind, and on the other on the results of epoch-making clinical observations and of experimentation in scientific laboratories up to the present moment. Man has long made practical use of the fact that the removal of the sex glands at a certain age will give us the docile ox in place of the unruly bull, the easily fattened and tender-fleshed capon for the muscular and stringy cock; and human society in its various stages of development has also practised this mutilation on its individuals for various reasons, religious, economic or penal. The sale of eunuchs in Bagirmi and other parts of North Central Africa still continues, we are told, and it was only on the accession of Pope Leo XIII. in 1878 that the practise of castrating boys in order to furnish the Sistine Choir its famous adult soprano voices was discontinued.

From remote antiquity, therefore, man has known that the gonads, or sex glands, exert a marked influence on the development and structure of the body, but until recent times there has existed no valid explanation, no correct theory of their relationship to the rest of the body. It is true, there were not wanting acute minds whose attempted explanation came close to the

truth, but experimental proof was lacking. We gather from Æsop's fable that it will not do for the various members of the body to fall out with one another, and the medicine of an older time has long used the expression *consensus partium* as indicating the interrelationship of the various organs. Even in quite modern times this *consensus* of the various organs was supposed to be entirely effected through the intermediation of the nervous system, a view tersely expressed by Cuvier when he said,

> Le système nerveux est, au fond, tout l'animal, les autres systèmes ne sont là que pour le servir.

Side by side with this view of the preponderating rôle of the nervous system we find the old humoral doctrine, having obtained new support in Harvey's discovery of the circulation, struggling to prove the importance of the blood stream for the interrelationship of the organs. In 1775, Théophile de Bordeu[22] of Montpellier and later Paris, a fashionable practitioner with considerable knowledge of anatomy, propounded the doctrine that every organ lives its own life and is the source of specific chemical substances (humeurs particulières) which are yielded up to the blood and which are necessary to the integrity of the body. The idea that every organ has its own special life is repeated again and again in Bordeu's writings:

> It must be remembered that each organic part of the living organism has its own manner of existence, of acting, of feeling and of moving: each has its own particular savor, structure, external and internal make up, odor, weight, manner of growth, of expanding and contracting; each competes after its own manner and for its share in the ensemble of all the functions, in the general life; each organ, in brief, has its own life and its own functions quite distinct from all others.[23]

[22] See his "Recherches anatomiques sur la position des glandes et sur leur action," Paris, 1752; and his "Analyse médicinale du sang," 1776.

[23] P. 942, "Analyse médicinale du sang," Vol. 2, "Œuvres complètes de Bordeu," edited by Richerand, Paris, 1818.

From the organs the blood derives a multitude of humors and "emanations" (nuées d'émanations qui composent et animent le sang).

> Comparable at bottom to fecundated white of egg, the blood (a fluid tissue which fills the vessels of the body) is animated by the semen, that is to say, it contains a certain quantity of *seminal emanations* which vivify it; it contains in the same way a portion of the bile, and also a portion of the milky juices, especially in infancy and in women at the time of pregnancy; it contains a colored part which is elaborated in the entrails; it has serosity in abundance; it contains an extract of each glandular organ which contributes its share to the emanations in which all the solid parts (of the blood) swim; a certain quantity of air; a portion of mucous substance. . . .[24]

Bordeu's theories in respect to the diseases that are consequent to a superabundance or wrong admixture of these various special principles or emanations, his various cachexias (cachexie bileuse, albumineuse, etc.) can not be considered here.

Three quarters of a century after Bordeu, in 1849, we find a German professor of physiology, in Göttingen, A. A. Berthold, giving the first experimental proof of the correctness of this theory. This experimenter, in a beautifully concise monograph of only four pages, describes his experiments upon young cockerels. By removing the sex glands from their normal position and transplanting them to another part of the body (to the outer surfaces of the intestine in the peritoneal cavity) where it was impossible for them to expel a secretion or to play any external rôle as sex glands, he was able to prove that these glands have two functions: (*a*) the well-known reproductive function, and (*b*) an important function in maintaining, as he says, the "*consensus partium.*" Such cockerels did not show the changes that were seen in the castrated bird; on the contrary, they developed into the usual type, remaining male birds in respect to their vocal capacity,

[24] P. 1,066, *ibid.*

their desire for battle, the growth of comb and wattles and the sexual instinct. Berthold draws the conclusion from his experiments that the generative organs influence the *consensus partium* by acting upon the blood and through this upon the organism as a whole.

The observations of Berthold were forgotten and even discredited (Rudolf Wagner) and they had no influence apparently on the development of work in this field during the following half century.

I can not leave this part of my subject without mentioning the work of the great Frenchman, Claude Bernard, whose discovery of glycogen in the liver and elsewhere must always rank as one of the great discoveries of physiology. With perfect justice Bernard declared that the conversion of glycogen into sugar and the passage of the latter into the blood constitutes the internal secretion of the liver, while the bile constitutes its external secretion.

One other investigator, the modern pioneer in this field, a restless spirit, a man of enthusiasms, possessing an original mind of a high order, one who is of especial interest to Americans, can not be passed by without mention. Charles Edward Brown-Séquard was born at Port Louis, Mauritius, on April 8, 1817. His father was an American, his mother a French woman, but he himself, it is stated, always wished to be regarded as a British subject. After a varied career in four countries (England, France, Mauritius and the United States) having held the chair of physiology in Harvard from 1864 to 1867, he finally, in 1878, succeeded Claude Bernard as professor of experimental medicine in the Collège de France, where he remained until his death in 1894.

As far back as 1869 Brown-Séquard took the position in his lectures in Paris that all glandular organs, irrespective of whether they possess external excretory ducts or not, give off to the blood substances which are useful and necessary for the body as a whole, an opinion, as we have seen, that had already been stated by Théophile de Bordeu in 1775. He even made experiments on himself with a testicular extract, and the meeting of the Paris Societé de Biologie, June 1, 1889, at which Brown-Séquard, then 72 years old, made his report on these experiments, Biedl calls "the true birthday of the doctrine of internal secretion."

From this time an ever-increasing army of experimental laboratory workers have been engaged in this field. Their names even can not here be given, neither can I go into detail with regard to the great and fundamental contributions that have been made by medical clinicians, surgeons and anatomists, as Basedow, Graves, Addison, Marie, Gull, Ord, Kocher, Reverdin, Minkowski, Von Mering, Sandström and others, to name only some of the leaders of the immediate past, not to speak of the excellent contributions that have been made in recent years by our own surgeons and internists.

And so there has gradually come into existence an enormous store of facts, physiological, pathological, chemical and clinical, in regard to a number of structures that are classed as endocrinous glands or organs of internal secretion.

What is meant to-day by this term, products of internal secretion, and what organs furnish principles that can be classed as internal secretions?

For the present we shall follow custom and apply the term *to definite and specifically acting indispensable chemical products of certain organs (organs that may or may not have an external secretion), which are poured into the blood and modify the development and growth of other organs,*

more especially during embryonic and early life, and which also greatly affect the entire metabolism, that of the nervous system included, during adult life. I regard it as not unlikely that with the growth of knowledge of the chemistry of the animal organism we shall drop the term entirely. We have already seen that the liver, according to Claude Bernard's view, has an internal secretion, yet this gland is not usually classed with the endocrinous organs. In a sense, too, as has been frequently pointed out, every cell of the body furnishes in the carbon dioxide which it eliminates a hormone or product of internal secretion, since under normal conditions the carbon dioxide of the blood is one of the chief regulators of the respiratory center, influencing this center by virtue of its acidic properties. These and other instances that could be given show that the term internal secretion could be greatly extended in its scope, but in the present state of our knowledge it is convenient to limit it to the products of a certain number of glands.

The generally accepted list of the organs of internal secretion is as follows, though even at this moment a foreign investigator[25] is asking us to accept certain newly discovered small structures located in the neck as belonging to our list: the thyroid, parathyroid, thymus, hypophysis cerebri, epiphysis cerebri, pancreas, mucosa of the duodenum, the two adrenal systems (the chromaphil tissue and the interrenal bodies) and the gonads, or sex glands.

Permit me to give you a few illustrations of the derangement of health and bodily structure that follow upon the removal or disease of these glands. Many of you have doubtless seen these illustrations, but I am giving them here for the benefit of those who have never been given proof of the great significance of these glands in order that they may have a background of fact for the better apprehension of certain chemical questions which I wish presently to bring to your notice.

The figure[26] is an illustration from a well-known paper of the Viennese surgeon, A. v. Eiselsberg, in which he describes the effects of removing the thyroid gland from young goats. The two animals here shown are of the same age and parentage. On the twenty-first day after birth v. Eiselsberg removed the thyroid gland from one of them. The incision healed by primary intention. After three weeks the control animal began to outgrow the one operated upon and when four months old the animals presented the appearance here shown. The goat with thyroid removed has shortened extremities, a shortened skull and an altered pelvis due to a delayed ossification at the epiphyseal line. The wool of this animal is longer and easily torn out by the handful, the sex glands are atrophied, the hypophysis is enlarged, the intelligence is lowered; in brief, a chronic pathological condition is produced in this experiment which finds an analogy in human beings and is known as *cachexia thyreopriva.* We can not enter into further details, but I may remark that the results obtained in such removal experiments vary greatly with the age and with the species of animal used.

In this figure we have the results of a similar experiment which nature herself has performed for us. The child here shown is a thirteen-year-old idiotic myxedematous dwarf whose general symptoms point to a congenital absence of the thyroid gland. Investigators have proved this to be the true cause by anatomical studies of the

[25] "Ueber eine neue Drüse mit innerer Sekretion (Glandula insularis cervicalis)," N. Pende, *Arch. f. mikroscop. Anat.*, Vol. 86, p. 193, 1914.

[26] The illustrations were shown in the lecture, but can not here be reproduced.

bodies of other congenital myxedematous children of this class.

Further illustrations were then given by means of lantern slides of endemic cretinism and goiter and it was shown by statistics and by a map of Europe that these abnormalities have very great economic significance, on account of their great prevalence in certain parts of central and western Europe and to a less degree in our own and other countries. For instance, in Switzerland one sixth of the male population is unfitted for military service by cretinism in some degree.[27]

After even these few illustrations of abnormalities that follow on removal or disease of these glands, I think you will agree with me that my colleague, Professor Barker, has not exaggerated their importance when he says,

More and more we are forced to realize that the general form and the external appearance of the human body depend to a large extent upon the functioning, during the early developmental period (and later), of the endocrine glands. Our stature, the kinds of faces we have, the length of our arms and legs, and the shape of the pelvis, the color and consistency of our integument, the quantity and regional location of our subcutaneous fat, the amount and distribution of hair on our bodies, the tonicity of our muscles, the sound of the voice and the size of the larynx, the emotions to which our *esteniour* gives expression—all are to a certain extent conditioned by the productivity of our hormonopoietic glands. We are simultaneously, in a sense, the beneficiaries and the victims of the chemical correlations of our endocrine organs.[28]

I can not here take up questions of therapeutics in this interesting field. I can only say that *aside* from surgical intervention and the brilliant results of thyroid treatment in cases once utterly hopeless, we have little to offer that has been *positively* established. Nor shall I attempt to discuss the interrelationship of these glands. It has become increasingly evident that to touch one of them is to touch all. Various writers have endeavored to express this interrelationship in a series of charts or diagrams. Of these diagrams D. Noël Paton has well said:[29]

They may well be a grotesque parody of what will ultimately be found to be the relationship of the activities of these organs. They are probably as near the truth as those quaint ancient maps of the Indies with their "here be gold" scrawled across them which served as the charts of our forefathers, and if, like them, they merely indicate the direction which further investigation should take and suggest lines of attack, they will have served their purpose.

Notable and well established, apparently, is the relationship existing between the gonads, the thyroid and thymus glands, the hypophysis and suprarenal glands. Very difficult is it also to unravel the relationship of the internal secretions as a whole to the nervous system, both central and peripheral.

In view of the fact that we so little understand the chemical principles elaborated in these organs and discharged by them into the blood, whereby the remarkable changes described above are effected, it is evident that further progress now waits on chemical discoveries.

[27] "Der Kretinismus," H. Vogt, in *Handbuch der Neurologie* (Lewandowsky), Vol. IV., Spezielle Neurologie, III., p. 139. Here also it is stated that the three Italian provinces, Piedmont, Lombardy and Venice had 120,000 cases of goiter and 13,000 cretins in 1883, the total population of these provinces at that time being 9,400,000. In 1908, according to Biedl, Austria had on the average 64 cretins to every 100,000 of the population. In 1873 France had 120,000 cretins in Savoy, the Maritime Alps and the Pyrenees. It will be seen that the thyreopathies constitute a heavy drain on the resources of European people.

Pictures of persons suffering from other disorders, as exophthalmic goiter, acromegaly or gigantism and parathyroid tetany, were also given with a brief statement of the glandular and general nutritive changes involved. Animals such as the monkey, the dog, the rat and others are likewise subject to disease of this gland.

[28] "On Abnormalities of the Endocrine Functions of the Gonads of the Male," *Am. Jour. Med. Sciences*, Vol. 149, p. 1, 1915.

[29] "Regulators of Metabolism," p. 183. Macmillan & Co., London, 1913.

The only fairly complete chemical work yet done on any of these organs is that on the suprarenal glands. These organs are two flattened, ductless, yellow-brown glands, each of which is loosely attached to the anterior and inner part of the summit of the corresponding kidney. The normal gland of a healthy man weighs, according to Elliott,[30] between four and five grams, and contains four or five milligrams of the characteristic principle concerning which I shall speak in a moment. These organs are essential to life; their destruction in man by tubercular and more rarely by other processes leads to a chronic condition characterized by gastro-intestinal symptoms, great muscular weakness and a bronzing of the skin and mucous membranes, this whole symptom complex being known as Addison's disease (1855). In man and the higher animals generally this organ is a double structure in which two parts which are quite separate and totally different in lower forms, as in the elasmobranch and teleostean fishes, are united in such a manner that one constitutes the medulla and the other the cortex of the gland, the latter completely enclosing the former.

The cortical part of the gland is called by histologists the inter-renal tissue. Biedl has shown that when this tissue is removed from selachians (where, as just stated, it constitutes a separate organ) the animal gradually weakens, no longer takes food and dies in fourteen to eighteen days. Still other experiments demonstrate that this cortical part of the gland exerts great influence on bodily growth and sexual development. Numerous researches of a chemical character have been carried out on this part of the gland, especially in respect to its lipoid content. Last year Voegtlin and Macht[31] isolated from it and also from blood serum a new crystalline substance which has a vaso-constricting action on the blood vessels and a digitalis-like action on the heart. This has been decided to be a lipoid closely related to cholesterin. As we are entirely ignorant of the means by which the adrenal cortex exerts its profound influence on the body, the isolation of this substance is of especial interest. For the present we can not state whether it represents one or all of the products of the internal secretion of the cortex, or whether, indeed, it has any connection at all with the function of the gland.

The medullary portion consists of cell groups which assume a brown color when treated with chromic acid or dichromates, in consequence of the reduction of these compounds to brownish or reddish-brown basic chromates. For this reason it has been designated the chromaphil tissue. Now such chromaphilic cell groups are not confined to the medulla of the suprarenal gland, but are also found lying alongside the abdominal aorta, in the carotid gland and in the sympathetic system.

It was known to earlier experimenters that aqueous extracts of the entire capsules were highly toxic to animals when injected directly into the circulation, but it remained for Oliver and Schäfer in 1894 to demonstrate that extracts of the medullary part, in the most minute quantity, cause a marked rise in blood pressure and greatly stimulate the heart. In 1897 I showed that the substance responsible for these actions could be isolated from the glands in the form of a benzoyl compound.[32] Salts of a

[30] "Death and the Adrenal Gland," *Quar. Jour. of Medicine*, Vol. 8, p. 47, 1914. An interesting paper by E. R. Weidlein, a fellow of the Mellon Institute, on the adrenal glands of the whale will be found in the *Jour. of Industrial and Engineering Chemistry*, Vol. 4, No. 9, September, 1912.

[31] "Isolation of a New Vasoconstrictor Substance from the Blood and the Adrenal Cortex," *Jour. Amer. Med. Assoc.*, Vol. 61, p. 2,136, 1913.

[32] For literature see Abel and Macht, *Jour. of*

base obtained by saponifying this benzoyl derivative were shown by me (1898) to possess the characteristic chemical and physiological properties of the gland itself. To the principle thus isolated I gave the name epinephrin. Very soon after this v. Fürth (1899–1900) isolated the principle under discussion in the form of an amorphous indigo-colored iron compound, and in 1901, Takamine and Aldrich succeeded independently in precipitating the native substance with the help of ammonia, and without first subjecting it to the more complicated processes which had been used by myself some years before.

These results were soon followed by the brilliant researches of a number of organic chemists, Dakin, Jowett, Pauly and Friedmann, which culminated in the synthetic production, first, of the racemic form by Stolz in 1906, and later of the levorotatory form by Flächer in 1908, the form in which the substance exists in the gland itself. The chemical history of this remarkable blood-pressure-raising constituent which is found wherever chromaphil tissue is encountered is therefore now a closed chapter. We are no longer dependent upon the glands of the ox or the sheep for its preparation for the many uses to which it is put by the medical specialist, the surgeon and the general practitioner, but shall always be able to produce it in our laboratories as long as coal-tar remains at our disposal. In chemical language it is described as a di-hydroxymethyl-aminoethylol benzene, or more concisely and simply, it is an aromatic amino alcohol. It is as noteworthy for its instability in solution as it is remarkable for its physiological properties. It is a true product of internal secretion and can apparently be detected in the venous blood of the adrenal glands.[33] I shall not further describe its chemical properties, but would call your attention to the fact that in at least one animal, a tropical toad, *Bufo agua*, this principle occurs also as a constituent of an external secretion.

Pharmacol. and Exp. Therapeutics, Vol. 3, p. 327, 1912.

The toad, I may say here, has a very interesting history.[34] It has been regarded from the earliest times as a poisonous animal and various races, including our own, have long made medicinal use of its skin. The Chinese to this day use as a cure for dropsy a preparation derived from toad skin, called *senso*. Among western nations it has always been a folk's remedy, and almost up to the time of the introduction of digitalis (1775) as a medical agent our very best medical authorities used these skins in cases of dropsy. Dr. Langworthy, Department of Agriculture, Washington, has given me the following recipe for making a toad ointment which was in use among our early New England colonists for the treatment of sprains and rheumatism. Toad ointment: good-sized live toads, 4 in number; put into boiling water and cook very soft; then take them out and boil the water down to one half pint, and add fresh churned, unsalted butter 1 pound and simmer together; at the last add tincture of arnica 2 ounces.

The particular toad, *Bufo agua*, to which I have referred, is of further interest because the aborigines of the Upper Amazon make an arrow poison from the creamy secretion that exudes from its skin glands when it is irritated or overheated, a poison

[33] It has not been conclusively shown that the blood-pressure-raising constituent of this blood is really epinephrin (adrenalin) and not an alteration product.

[34] Abel and Macht, "The Poisons of the Tropical Toad, *Bufo agua*," *Jour. Amer. Med. Assoc.*, Vol. 56, p. 1,531, 1911, and "Two Crystalline Pharmacological Agents obtained from the Tropical Toad, *Bufo agua*," *Jour. Pharmacol. and Exp. Therapeutics*, Vol. 3, p. 1,319, 1912.

so powerful that it kills in a few moments large game, such as the stag or the jaguar.

Two years ago I was examining a specimen of this giant among toads when I noticed that this creamy secretion made on a scalpel a peculiar, greenish-blue discoloration. I at once remembered where I had seen this color years before on a scalpel used in cutting into the medulla of a suprarenal gland. Working from this hint, I was soon able to isolate the now familiar substance, adrenalin or epinephrin, from this toad's glands. Scientists have been not a little surprised to learn that this substance is present in very large amounts in the skin of this tropical toad. It is not found in the skin of the common American toad.

I also succeeded in isolating the principle to which the toad skin owes its curative power for dropsy, a very different principle from epinephrin. It has been obtained in the form of beautiful crystals and has the composition represented by the formula, $C_{18}H_{24}O_4$, and has been named bufagin.

Just as in the case of bleeding, we have here another instance of the every-day observation of mankind justified by science. That powdered toad skin could cure dropsy has been ridiculed by the learned for a century, and now we possess in bufagin and in the slightly different bufotalin, which has only recently been obtained in crystalline form from the skin of the common European toad, the actual proof of the correctness of the old belief.

We are now studying the chemical constitution of bufagin in my laboratory, and although this problem is one of great difficulty, we hope, nevertheless, that our work will throw some light on the fundamental chemical properties of cardiac stimulants. We now also understand why the secretion of the skin of *Bufo agua* may be used as an arrow poison, since it contains these two powerful drugs, epinephrin and bufagin, which in overdose act fatally on the heart and blood vessels.

We can not leave the consideration of this subject without noting the influence that the study of the pharmacological properties of epinephrin has exerted on certain departments of medical science.

Chromaphilic cells of the body, whether located in the medullary portion of the suprarenal gland, or elsewhere, all yield epinephrin, and modern studies have shown that these chromaphilic cells are intimately related to the sympathetic nervous system in their origin, and have differentiated themselves from it. We are not surprised, therefore, to find that epinephrin, the secretory product of these cells, has an elective affinity for the sympathetic nervous system, the thoracico-abdominal part of the autonomic system. The well-known symptoms that follow upon the administration of epinephrin, extreme vaso-constriction, tachycardia, dilatation of the pupil, inhibition of peristaltic movement in the alimentary canal, contraction of the pyloric and ileo-cecal sphincters, increased motility of the pregnant uterus and glycosuria have all been shown to be due to the fact that this hormone stimulates and sensitizes the sympathetic myoneural and adenoneural junctions or terminations of the sympathetic nervous system. Numerous experiments have shown that the changes induced by epinephrin in the activity of various organs which are innervated by the sympathetic nervous system are in all respects like those that are brought about by electrical stimulation of this system, and it is apparent that such experiments have already assisted in elucidating many obscure points in the functional activity of this part of the nervous system.

Other interesting observations which deal with the action of this principle upon

the metabolism of the body or with the pathological changes induced by toxic doses can not be taken up here.

The discovery of the chemical structure and pharmacological properties of epinephrin has greatly encouraged investigators to take up the isolation of other active principles. Thus Abelous[35] and his coworkers showed that the intravenous injection of extracts from putrid meat caused a rise of an animal's blood pressure. Barger and Walpole[36] then proved that this effect was due to the presence of isoamylamine, phenyl-ethylamine and para-hydroxyphenylethylamine.

These amines are produced by putrefactive bacteria from proteids, and they exhibit pressor or blood-pressure-raising effects that in general are very similar to those produced by epinephrin. A close similarity in chemical structure of two of these amines, phenyl-ethyl-amine and para-hydroxyphenylethylamine, to epinephrin is shown in the graphic chemical formulæ which will presently be given. The last-named base is of special interest to us, since Barger has discovered that it is also present in ergot and is in some degree responsible for the characteristic activities of this drug. It is also present to a small extent in Emmenthaler cheese. More remarkable still is the discovery of Henze that this amine is the effective principle of a highly active poison produced by the posterior, so-called salivary glands of a certain cephalapod found in the Bay of Naples. It has long been known that this mollusc renders its prey, as the crab, quickly helpless by means of this poison and until Henze's discovery it was believed to be a toxalbumin.

We find, therefore, that p-hydroxyethylamine is produced by putrefactive bacteria, that it is present in ergot (the permanent mycelium of the fungus, *Claviceps purpurea*), and that it is the product of the metabolism of a glandular tissue. In each case it may be assumed that it is obtained by chemical reactions from the protein molecule, its immediate precursor being the innocuous tyrosin.

By merely splitting off a molecule of CO_2 from tyrosin, as was demonstrated by Barger, we at once secure this amine, as shown by the accompanying formulæ. As a recent writer has remarked, "Our poisons and our drugs are in many instances the close relatives of harmful compounds that represent the intermediary steps in the daily routine of metabolism."[37]

The fact that putrefactive microorganisms can produce poisonous amines by decarboxylating the harmless amino-acids has become of the highest importance to medicine. It would appear that we have at last got onto the right road for the chemical investigation of alimentary toxemia and its alleged consequences, such as arteriosclerosis and chronic renal disease. Phenylalanine, tyrosine, tryptophane and histidine, the harmless precursors of toxic amines, are always present in the intestine, and when they are acted upon by an excessive number of certain microorganisms the resulting toxic bases will surely be formed in excess. If they are then taken up into the blood in quantities too large for transformation by the liver, or other defensive organs, into less harmful derivatives they must inevitably manifest their pharmacological and toxicological properties. Let me give but one further example of recent advances in this field. It has been shown by Barger and Dale[38] that the highly poi-

[35] *Compt. rend. Soc. de Biol.*, Vol. 58, I., pp. 463 and 530 (1906), Vol. 64, p. 907, 1908.

[36] *Jour. of Physiol.*, Vol. 38, p. 343, 1909.

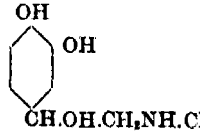
[37] *Jour. Amer. Med. Assoc.*, editorial comment, Vol. 62, January 3, 1914.

[38] *Jour. of Physiol.*, Vol. 40, p. 1,910; Vol. 41, p. 499, 1910–11. Consult also the work of Ackermann, who first demonstrated that when pure his-

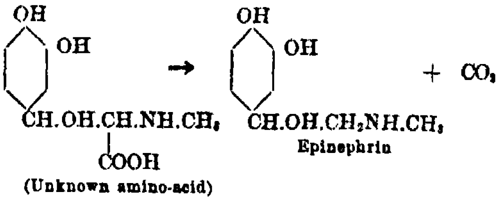
sonous depressor base, β-imino-azolylethylamine may be isolated from the intestinal mucosa, and Berthelot and Bertrand[39] have demonstrated that it is in all probability formed in the intestinal canal from histidine by the decarboxylating action of a bacillus newly discovered by them which they have named *Bacillus aminophilus intestinalis*. These investigators have shown that their bacillus produces the base from histidine even in the presence of 0.3 per cent. lactic acid, unless, indeed, an excess of glucose be present, in which case only this is attacked, and they have also made the interesting observation that rats, fed on a milk diet, are not affected by either *Proteus vulgaris* or *Bacillus aminophilus intestinalis* when these organisms are given separately, but that when they are given simultaneously the rats succumb to a diarrhea in from four to eight days.

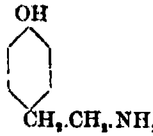
Investigations on the pharmacological behavior of β-imino-azolylethylamine have shown that it acts very powerfully on plain muscle, stimulating the isolated uterus, for example, to contraction in the almost unbelievable dilution of 1:250,000,000.[40] The muscular coats of the guinea-pig's bronchioles are so sensitive to its action that large pigs are killed in a few minutes by the intravenous injection of a half a milligram. The death of the animal is due to asphyxia produced by a spasm of the bronchioles. Recently investigators have been much occupied in studying similar features in the symptoms of the poisoning by large doses of the base and those observed in anaphylactic shock (action on the circulation, body temperature, respiration, etc.) and some do not hesitate to affirm that the poisons of anaphylactic shock must be put into the same pharmacological class with the proteinogenous bases that we have been considering.

We may now give the chemical formulæ that illustrate the various relationships that have been discussed.

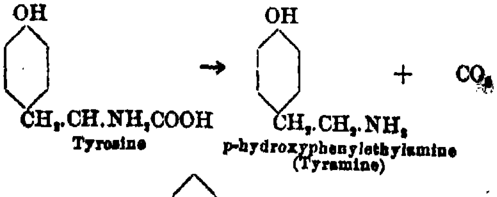
1. 

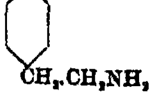
Epinephrin, adrenaline, suprarenin, possibly derived by decarboxylation from a still unknown amino acid, dioxyphenyl-α-methylamino-β-oxypropionic acid, as suggested by M. Guggenheim. *Therap. Monatsh.*, XXVII., p. 508, 1913.



2. 

p-hydroxyphenylethylamine, derived from p-hydroxyphenyl-α-amino-propionic acid, or tyrosine, as follows:



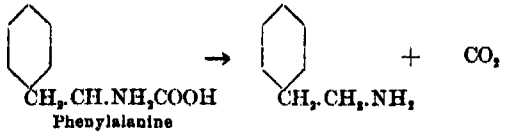
3. 

tidine is submitted to the action of putrefactive bacteria a considerable yield of β-imino-azolylethylamine is produced. *Ztschr. f. physiol. Chem.* Vol. 64, p. 504, 1910.

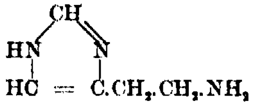
[39] *Compt. rend. de l'Acad. des Sciences*, Vol. 154, pp. 1,643 and 1,826. See also Mallenby and Twort, "On the Presence of β-imino-azolylethylamine in the Intestinal Wall, with a Method of Isolating a Bacillus from the Alimentary Canal which Converts Histidine into this Substance," *Jour. of Physiol.*, 45, p. 53.

[40] See Fröhlich and Pick, *Arch. f. Exp. Pathol. u. Pharmakol.*, Vol. 71, p. 23, and Sugimoto, *ibid.*, Vol. 74, p. 27.

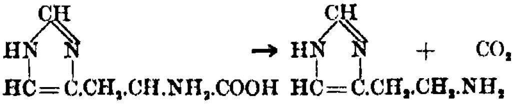
Phenylethylamine, derived by decarboxylation from phenyl-α-amino-propionic acid or phenylalanine, as follows:



4.



β-Imidoazolylethylamine, histamin, obtained by decarboxylation of histidine, as follows:



IV. I come now to the concluding portion of my address. That science in general is a basic fact in the development of commerce and industry seems to be fully appreciated in this city, as shown by the establishment of the Mellon Institute of Industrial Research and School of Specific Industries, through the munificence of two of your public-spirited citizens, the Messrs. Richard B. and Andrew W. Mellon. I believe that no act of their lives will give them more enduring satisfaction than this which marks out your city as one more great center of industry which acknowledges the dependence of all advance in material civilization on the quiet labors of the investigator. This dependence has been forcibly expressed by former ambassador James Bryce in an address to the members of the National Academy of Sciences.

> You men of science are really the rulers of the world. It is in your hands that lies control of the forces of activity; it is you who are going to make the history of the future because all commerce and all industry is to-day far more than ever the child and product of science. . . . It is in your hands that the future lies, far more than in those of military men or politicians.

Let me also in this connection recall the inspiring words of that great investigator and benefactor of mankind, Louis Pasteur, which point out the still wider influence of science. He wrote:

> Laboratories and discoveries are correlative terms; if you suppress laboratories, physical science will be stricken with barrenness and death, it will become mere powerless information instead of a science of progress and futurity; give it back its laboratories, and life, fecundity and power will reappear. . . . Ask that they be multiplied and completed. They are the temples of the future, of riches and of comfort. There humanity grows greater, better, stronger. There she can read the works of nature, works of progress and universal harmony, while humanity's own works are too often those of barbarism, of fanaticism and destruction.

And here I shall permit myself to speak more specifically of the paramount importance of chemistry in biological and medical research. The subjects to which I have been calling your attention to-night, viz., the still unknown chemical properties and molecular structure, with the single exception of epinephrin, of the mysterious, correlating substances stored and formed in the many organs of internal secretion, and the equally unknown character of numerous constituents of the circulating blood, both offer a virgin field to the biologist with a chemist's training.

The practical importance of decisive chemical advances along this line are hardly to be overstated. At present we meet only vast confusion and contradictory theories. A single clean-cut discovery, the separation from another of these glands of a definite chemical individual shown to possess one or more of the specific actions of the gland would clear away the mists at once, and we should see the same rapid progress that has followed the isolation of epinephrin, which is only one, and perhaps not the most important, constituent of the suprarenal gland.

What a flood of light was thrown on the whole question of carbohydrate metabolism

in the discovery by Claude Bernard of glycogen in the liver! Innumerable fruitful researches have come from this as a starting-point, and their bearing on our understanding of such diseases as diabetes mellitus has been of the most fundamental nature.

Miescher's discovery of the existence of protamin nucleate in the spermatozoan heads of the Rhine salmon is another case of the far-reaching importance of a definite chemical fact for both biology and medicine. For further discoveries in the field of nucleinic acids, a later worker, Professor Kossel, received the Nobel prize. To name only one practical outcome of these discoveries, our theories of the origin of uric acid in gout and of the purins in general have undergone entire transformation.

The actual finding of definite and specific chemical principles in the organs of internal secretion has in each case an importance in the way of explaining and correlating a large number of disconnected facts, only to be likened to the discovery of the etiological cause of an infectious disease. The bacilli of tuberculosis or of typhoid, or the protozoa of syphilis and sleeping-sickness, are illuminating examples in point. Here, too, simplicity at once took the place of what had been confused and complex, and a multitude of already recorded facts fell into their proper place.

From my insistence on our ignorance of the specific secretory products of the organs of internal secretion, and of numerous constituents of the blood, it is not to be inferred that important chemical facts are lacking with regard to these tissues. On the contrary, a vast number of facts, some of immediate, others of potential significance, have been amassed by an army of workers in the past 30 years; it is their *relation to each other and to an underlying cause* which remains obscure. For example: it has been recently shown by Cramer and Krause[41] that when fresh thyroids are fed to cats or rats kept on a carbohydrate-rich diet, the glycogenic function of the liver is inhibited, and in consequence this organ is soon found to contain only traces of glycogen. And these investigators suspect that the well-known action of thyroid secretion on the metabolism is effected through this change in the carbohydrate metabolism. But this important discovery can not reach its full significance until we know the chemical properties of the special hormone of the thyroid gland which is carried in the blood to the liver and there prevents the formation of glycogen even though the food may contain an abundance of carbohydrate.

Thus, too, one of the facts known about the parathyroids, as shown by MacCallum and Voegtlin,[42] is that their removal from the body is followed by increased excretion of calcium salts. This chemical discovery also can not yet be brought into a causal connection with a definite chemical constituent of the gland.

That I may not be accused of placing too much emphasis upon only one mode of attack in biological and medical research, let me say that I am fully aware of how many-sided are all these problems, and that fundamental discoveries have been made and will continue to be made without the aid of chemistry. This is true especially in the field of morphology. But as soon as we touch the complex processes that go on in a living thing, be it plant or animal, we are at once forced to use the methods of this science. No longer will the microscope, the kymograph, the scalpel avail for the complete solution of the problem. For the further analysis of these phenomena which

41 *Proc. Roy. Soc. B.*, Vol. 86, p. 550, 1913.

42 *Jour. Exp. Med.*, Vol. 11, p. 118, 1909.

are in flux and flow, the investigator must associate himself with those who have labored in fields where *molecules and atoms, rather than multicellular tissues or even unicellular organisms, are the units of study.* To-day investigators in biology and medicine are reaching out with eager hands into the more exact branches of science. The great progress in biology and in medicine that has been made during the past century proves that advantages hardly to be imagined must follow upon the further application of physics and chemistry to these sciences. A striking example of the debt which medicine owes to that newer branch of chemistry called physical chemistry is seen in our better understanding in the last twenty years of certain dynamic equilibria of the body, such as the relationship between the hydrogen and the hydroxyl ions of the blood and tissues, of surface tension, osmotic pressure and the colloidal state.

I also recognize that all the various aspects of any one problem in our field are intimately bound together, and that progress along the chemical side, for instance, of a question may have to wait on the clearing up of the morphological side. When I have the honor of being consulted by a young man who has not yet found himself intellectually but who is filled with the desire to devote his life to some branch of medicine, be it clinical medicine, pathology, hygiene, bacteriology, physiology or pharmacology, my advice always is, "Study chemistry for at least three years. Try with all your power to master enough of this great science to start you in your career." Why not make this attempt at a time of life when one still takes kindly to a rigid discipline[43] such as this science exacts? To this preparation must be added the special medical training of another four or more years. A long road to travel? But I find that many young men have entered upon it with great enthusiasm.

I do not mean that this long tutelage is to be a cramming process. I have in mind conditions where these students shall be constantly under the influence of teachers who are themselves investigators and daily engaged in the search for new truths. Under the stimulus of such examples our young man is saved from the sterile life of the mere crammer, because he sees the relation of what he learns to living questions. During this period of study and growth he will himself make occasional attempts at the solution of problems. Even with the best preparation, workers in our fields have always to return again and again to the fundamental sciences for assistance.

But to what end is all this preparation for our young man? Is it solely that he may solve problems whose solution is of practical value to mankind? Is his mind to shape itself only to the insistent demands of utility? Even then our method of training will yield the largest profit. But it does vastly more than that. Thus trained our young scholar will be able to see beyond the immediately practical problem, even though it be as great a thing as the discovery of the cause and cure of the plague that decimates a people. *Greater even than the greatest discovery is it to keep open the way to future discoveries.* This can only be done when the investigator freely dares, moved as by an inner propulsion, to attack problems not because they give promise of immediate value to the

[43] The professor of physics in McGill University, Dr. A. S. Eve, has recently expressed himself as follows in a paper describing modern discoveries on the constitution of the atom (*Jour. Franklin Institute*, 1915, p. 269): "It may be noted that the discoveries set forth in this brief summary have been achieved by savants in the western half of Europe, and it may be asked if the education in the New World is at the present time sufficiently thorough, imaginative and philosophical."

human race, but because they make an irresistible appeal by reason of an inner beauty. Some of the greatest investigators indeed have been fascinated by problems of immediate utility as well as by those that deal with abstract conceptions only. Helmholtz invented the ophthalmoscope and thus made modern ophthalmology possible, and at the same time did work of the highest order in theoretical physics and wrote on the nature of the mathematical axioms and the principles of psychology. Lord Kelvin took out patents on great improvements in the compass and on oversea telegraphy, and also made contributions to our knowledge of the ultimate constitution of the atom and the properties of the ether. From this point of view the investigator is a man whose inner life is *free* in the best sense of the word. In short, *there should be in research work a cultural character, an artistic quality, elements that give to painting, music and poetry their high place in the life of man.*

Ladies and gentlemen, I have attempted in this hour to point out some recent advances that have been made in the study of the blood and of the organs of internal secretion, and have cited the beneficent effects of even these small advances—a very few bright stars in a darkened sky—in order to emphasize the great rôle that chemistry is destined to play in biology and medicine. I have strongly urged that those who are to be medical teachers and investigators should not content themselves with a mere smattering, but endeavor to acquire a really sound training in one of the fundamental sciences.

You, my colleagues, working with open-minded and generous trustees, must see to it that the men selected for important posts shall be those that are capable of training and inspiring the young men who in their turn will furnish the leadership of the future.

In our country many agencies combine to foster the higher learning. It is to the lasting honor of men of wealth that they have appreciated the need for institutes of research and in a number of notable instances have placed large sums at the disposal of science. They have responded nobly to that appeal of Pasteur which I have already cited in which he calls laboratories "the temples of the future, of riches and of comfort."

John J. Abel

The Johns Hopkins Medical School

CHARLES WILLIAM PRENTISS

Charles William Prentiss, professor of microscopic anatomy in the Northwestern University Medical School, died at Chicago on the twelfth day of June. Born in Washington, D. C., August 14, 1874, he spent many of his early years at Middlebury, Vermont.

His undergraduate work was done at Middlebury College, where his father, Dr. Charles E. Prentiss, was librarian. He was graduated with honors in 1896 but remained there another year as a graduate student. During the next three years he was at Harvard University in the department of zoology. Here he received the degree of doctor of philosophy in 1900. The following year was spent at the Harvard Medical School as instructor in anatomy. He was then awarded a Parker Traveling Fellowship and studied in Europe for two years. Although the greater part of this time was spent at Freiburg and Naples his work with Bethe at Strassburg had the more important influence on his career.

On his return to America he held appointments successively in the zoological departments of Western Reserve University and the University of Washington, Seattle. While in the latter place he first developed the symptoms of duodenal ulcer from which he suffered for the last eight years. He came to Northwestern University Medical School as assistant professor of anatomy in 1909 and was made professor of microscopic anatomy in 1913.

Professor Prentiss was a member of the Society of Naturalists, the Society of Zoologists and the Association of Anatomists. He was the author of many papers presenting the results of his own investigations in the fields of zoology and anatomy among the more important of which may be mentioned:

1. "The Otocyst of Decapod Crustacea," *Bull. Mus. Comp. Zool.*, 1901.

This was his thesis for the doctorate and was a well-rounded piece of histological and physiological work.

2. "Polydactylism in Man and the Domestic Animals," *Bull. Mus. Comp. Zool.*, 1903.
3. "The Neurofibrillar Structure in the Ganglia of the Leech and Crayfish with Especial Reference to the Neurone Theory," *Jour. Comp. Neur.*, 1903.
4. "The Nervous Structures in the Palate of the Frog," *Jour. Comp. Neur.*, 1904.
5. "The Development of the Hypoglossal Ganglia of Pig Embryos," *Jour. Comp. Neur.*, 1910.
6. "The Development of the Membrana Tectoria with Reference to its Structure and Attachments," *Amer. Jour. Anat.*, 1913.

Dr. Prentiss's "Text-book of Embryology" published in January, 1915, less than six months before his death, met at once with a very favorable reception. It is an example of text-book-making at its very best. The wealth of excellent illustrations and the clear concise text make it indispensable for the student of embryology. In it there are also may contributions of an original character not published elsewhere.

Professor Prentiss's scientific work was characterized by a scrupulous attention to detail and by the perfection of his technical methods. He handled with great success and on difficult material the most delicate of neurological methods—the methylene blue stain. His dexterity was shown again in remarkable dissections of embryos, drawings from which appear in his book. He brought to all his work an unusually clear mind and a keen insight into fundamental problems.

Reticent, almost shy, by nature, and prevented by the condition of his health from often joining his colleagues at the regular Christmas meetings Dr. Prentiss was intimately known to only a chosen few. To them he was endeared by reason of his unfailing good humor, generous motives and loyalty to high ideals and to his friends. Admired and respected by all conscientious students and loved by those who came into close contact with him, he helped greatly toward the establishment of high standards of scholarship and manhood in the student body.

In his death we lose a comrade whom we esteemed most highly, a generous and faithful friend.

S. WALTER RANSON

CHICAGO,
June 24, 1915

FRATERNITAS MEDICORUM

THE following appeal has been addressed by the distinguished committee whose names are appended to members of the medical profession. Every physician is entitled to membership in the Brotherhood (Fraternitas Medicorum = F.M.); there is no fee attached to this membership. However, in order to be able to maintain the organization, distribution of appropriate literature, etc., voluntary contributions will be welcome. Enrollment of membership as well as contributions are to be sent to The Medical Brotherhood, care of Dr. S. J. Meltzer, 13 West 121st Street, New York City.

AN APPEAL

To the men and women engaged in medical practise and the advancement of the medical sciences.

The present horrible war among civilized nations has brought out impressively certain sad facts; that although there are civilized *individual* nations, we are still very far from having a civilized humanity—there is an abyss between *intra*national and *inter*national morality; that, no matter how cultured and enlightened nations may be, they still settle their international differences by brute force, by maiming and killing their adversaries; and, finally, that the present high development of science and invention in individual nations only serves to make the results of this war more destructive than any other in history.

The war has demonstrated, however, one encouraging fact, namely, that among all the sciences and professions, the medical sciences and medical practise occupy an almost unique relationship to warfare, and that, among all the citizens of a country at war, medical men and women occupy a peculiar and distinctive position.

No discovery in medical science has been utilized for the purpose of destroying or harming the enemy. Medical men in each of the warring countries are as courageous, as patriotic, as any other citizens, and are as ready to die or to be crippled for life in the service of their country as any other class of their fellow countrymen. But their services, however, consist in ministering to the sick and to the injured and in attending to the sanitary needs. Furthermore, they often risk their lives by venturing into the firing line to bring the injured to places of safety and to attend to their immediate needs. *In these heroic and humanitarian acts friend and foe are treated alike.* Finally, the majority of the members of the medical profession and of the medical journals of the neutral as well as of the warring countries, abstain from public utterances that might be grossly offensive to any of the belligerent nations.

These facts—this advanced moral position in international relations which medicine and its followers are permitted to occupy in all civilized nations ought to be brought to the full consciousness of the men and women engaged in the medical sciences or in medical practise. Such a realization could not fail to have an elevating influence upon the medical profession itself, and would probably exert a favorable influence upon the development of international morality in general.

At the dawn of history, medical men were frequently also the exponents of philosophy and morals. In the middle ages, when knowledge became specialized, medical men more and more devoted their activity exclusively to medical practise. Because of its inefficiency at that time, medicine lost its prestige. In recent times, however, medicine is becoming an effective science; one marvelous discovery has followed another, and the efficiency of medical practise has been rapidly increasing. Medicine makes habitable to man hitherto uninhabitable parts of the world. It prevents disease; and, with increasing theoretical and practical efficiency, medicine is learning to alleviate and cure disease and injuries. Medical science and medical men have steadily risen in the esteem of civilized mankind. *May not the medical sciences and medical men become again the standard bearers of morality, especially of international morals?*

To accomplish these objects, it is proposed to organize as large and effective an association as may be possible, of men and women engaged in the medical sciences or in medical practise under the name of

THE MEDICAL BROTHERHOOD FOR THE FURTHERANCE OF INTERNATIONAL MORALITY

It is obvious that such a brotherhood could not exercise an important influence at once. But our modest expectation for prompt results should not prevent us from attempting *now* to take the first step in the right direction. Many important results have often had small beginnings.

A committee of physicians and medical investigators request you herewith to enroll as a member, and to declare your willingness to endorse and support the moral standard which the medical profession generally upholds when called upon to perform its patriotic duties in an international strife.

It should be expressly understood that it is not the object of the proposed brotherhood to influence the feelings and views of any one regarding the problems involved in the present war. It is desired merely to bring to the full consciousness of the members of the medical profession the exceptional moral position which all civilized nations, even while at war, *permit* and *expect* medical men to occupy, at least as long as they remain in the medical profession and act in this capacity. This consciousness can not fail to elevate the moral standards of physicians. Furthermore, after the close of the present war, the brotherhood could without doubt facilitate the reunion of the members of

the medical profession of all the nations which are now at war and increase good feeling among them. A humanitarian body such as the proposed brotherhood, if already in existence and ready for service, might and could be of the greatest usefulness in many ways.

EXECUTIVE COMMITTEE

Residents of the City of New York

President—Dr. S. J. Meltzer, member, Rockefeller Institute.

First Vice-president—Dr. Rufus Cole, director, Rockefeller Hospital.

Second Vice-president—Dr. S. Josephine Baker, director, Department of Child Hygiene.

First Secretary—Dr. Wm. J. Gies, professor of biological chemistry, Columbia University.

Second Secretary—Dr. Harlow Brooks, professor of clinical medicine.

Treasurer—Dr. Robert T. Morris, professor of surgery, Post-graduate Medical School.

COUNCILORS

Dr. Abraham Jacobi.

Dr. Robert Abbe, surgeon to St. Luke's Hospital.

Dr. John Winters Brannan, president, medical board, Bellevue Hospital.

Dr. J. A. Fordyce, professor of dermatology, College of Physicians and Surgeons.

Dr. Nellis B. Foster, assistant professor of medicine, Cornell University Medical School.

Dr. S. S. Goldwater, commissioner, Department of Health.

Dr. Graham Lusk, professor of physiology, Cornell University Medical School.

Dr. William H. Park, professor of bacteriology, University and Bellevue Medical College.

Dr. John Allen Wyeth, president, New York Polyclinic.

HONORARY PRESIDENTS

Dr. Russell H. Chittenden, director, Sheffield Scientific School, Yale University, New Haven.

Dr. W. T. Councilman, professor of pathology, Harvard Medical School, Boston.

Dr. W. C. Gorgas, surgeon-general of the Army, Washington, D. C.

Dr. W. S. Halsted, professor of surgery, Johns Hopkins Medical School, Baltimore.

Dr. W. H. Howell, professor of physiology, Johns Hopkins Medical School, Baltimore.

Dr. Abraham Jacobi.

Dr. W. W. Keen, president, International Surgical Congress; president, American Philosophical Society, Philadelphia.

Dr. Edward L. Trudeau, Saranac Lake, New York.

Dr. James Tyson, professor of medicine, emeritus, University of Pennsylvania, Philadelphia.

Dr. Victor C. Vaughan, professor of hygiene and physiological chemistry, Ann Arbor.

Dr. William H. Welch, president, National Academy of Sciences; professor of pathology, Johns Hopkins Medical School, Baltimore.

ADVISORY COMMITTEE

HONORARY VICE-PRESIDENTS

Dr. J. J. Abel, professor of pharmacology, Johns Hopkins Medical School, Baltimore.

Dr. Herman M. Biggs, commissioner, State Board of Health, New York City.

Dr. Frank Billings, dean, Rush Medical College, Chicago.

Dr. Clarence John Blake, professor of otology, emeritus, Harvard Medical School, Boston.

Dr. W. B. Cannon, professor of physiology, Harvard Medical School, Boston.

Dr. W. H. Carmalt, professor of surgery, emeritus, Yale University Medical School, New Haven.

Dr. George Dock, professor of medicine, Washington University Medical School, St. Louis.

Dr. James Ewing, professor of pathology, Cornell University Medical School, New York City.

Dr. Alice Hamilton, expert on occupational diseases, Federal Bureau of Labor Statistics, Washington.

Dr. L. Hektoen, professor of pathology, Rush Medical College, Chicago.

Dr. Howard A. Kelly, professor of gynecology, Johns Hopkins Medical School, Baltimore.

Dr. Robert G. LeConte, president, American Surgical Association, Philadelphia.

Dr. Rudolph Matas, professor of surgery, Tulane University, New Orleans.

Dr. William J. Mayo, Rochester, Minn.

Dr. Charles K. Mills, professor of neurology, University of Pennsylvania, Philadelphia.

Dr. John B. Murphy, professor of surgery, Northwestern Medical School, Chicago.

Dr. E. L. Opie, professor of pathology, dean, Washington University Medical School, St. Louis.

Dr. Charles A. Powers, professor of clinical surgery, emeritus, University of Colorado, Denver.

Dr. W. L. Rodman, president, American Medical Association, Philadelphia.

Dr. G. E. deSchweinitz, professor of ophthalmology, University of Pennsylvania, Philadelphia.

Dr. Henry Sewall, president, Association of American Physicians, Denver.

Dr. F. C. Shattuck, professor of medicine, emeritus, Harvard Medical School, Boston.

ADVISORY COMMITTEE

Dr. Isaac Adler, consulting physician, German Hospital, New York City.

Dr. Fred H. Albee, professor of orthopedic surgery, New York City.

Dr. Carl L. Alsberg, chief of bureau of chemistry, Washington, D. C.

Dr. James M. Anders, professor of medicine, Medico-Chirurgical College, Philadelphia.

Dr. John F. Anderson, director, Hygienic Laboratory, Washington, D. C.

Dr. John Auer, associate member, Rockefeller Institute, New York City.

Dr. Edward R. Baldwin, Saranac Lake, New York.

Dr. Helen Baldwin, attending physician, New York Infirmary Women and Children, New York City.

Dr. J. C. Bloodgood, associate professor of surgery, Johns Hopkins Medical School, Baltimore.

Dr. George Blumer, professor of medicine, dean, Medical School, Yale University, New Haven.

Dr. Joseph A. Capps, associate professor of medicine, Rush Medical College, Chicago.

Dr. A. J. Carlson, professor of physiology, University of Chicago, Chicago.

Dr. Henry Dwight Chapin, professor of medicine, New York Polyclinic, New York City.

Dr. Henry A. Christian, professor of medicine, Harvard Medical School, Boston.

Dr. Frank S. Churchill, associate professor of pediatrics, Rush Medical College, Chicago.

Dr. S. Solis Cohen, professor of clinical medicine, Jefferson Medical College, Philadelphia.

Dr. C. G. Coakley, professor of laryngology, University and Bellevue Medical College, New York City.

Dr. Warren Coleman, professor of clinical medicine, Cornell Medical School, New York City.

Dr. Joseph Collins, neurologist, Neurological Institute, New York City.

Dr. T. S. Cullen, associate professor of gynecology, Johns Hopkins Medical School, Baltimore.

Dr. Elizabeth M. Cushier, New York City.

Dr. Samuel G. Dixon, commissioner, State Board of Health, Philadelphia.

Dr. Theodore Diller, associate professor of clinical neurology, University of Pittsburgh, Pittsburgh.

Dr. I. Dyer, dean, Tulane University, New Orleans.

Dr. F. X. Dercum, professor of nervous and mental diseases, Jefferson Medical College, Philadelphia.

Dr. Harold C. Ernst, professor of bacteriology, Harvard Medical School, Boston.

Dr. D. L. Edsall, professor of clinical medicine, Harvard Medical School, Boston.

Dr. C. A. Elsberg, surgeon, Mt. Sinai Hospital, New York City.

Dr. Henry L. Elsner, professor of medicine, University of Syracuse, Syracuse, New York.

Dr. Joseph Erlanger, professor of physiology, Washington University Medical School, St. Louis.

Dr. Charles H. Frazier, professor of clinical surgery, University of Pennsylvania, Philadelphia.

Dr. T. B. Futcher, associate professor of medicine, Johns Hopkins Medical School, Baltimore.

Dr. Henry B. Favill, professor of clinical medicine, Rush Medical College, Chicago.

Dr. Fielding H. Garrison, editor, *Index Medicus*, Washington, D. C.

Dr. Arpad G. Gerster, professor of clinical surgery, Columbia University, New York City.

Dr. Joel E. Goldthwait, orthopedist, Boston.

Dr. Virgil P. Gibney, professor of orthopedic surgery, College of Physicians and Surgeons, New York City.

Dr. H. A. Hare, professor of therapeutics and diagnosis, Jefferson Medical College, Philadelphia.

Dr. R. A. Hatcher, professor of pharmacology, Cornell University Medical School, New York City.

Dr. I. Minis Hays, secretary, American Philosophical Society, Philadelphia.

Dr. F. P. Henry, professor of medicine, Woman's Medical College of Pennsylvania, Philadelphia.

Dr. Yandell Henderson, professor of physiology, Yale University, New Haven.

Dr. A. W. Hewlett, professor of medicine, University of Michigan, Ann Arbor.

Dr. James B. Herrick, clinical professor of medicine, Rush Medical College, Chicago.

Dr. C. F. Hoover, professor of medicine, Western Reserve University, Cleveland.

Dr. J. W. Holland, professor of physiological chemistry, emeritus, Jefferson Medical College, Philadelphia.

Dr. John Howland, professor of pediatrics, Johns Hopkins Medical School, Baltimore.

Dr. Reid Hunt, professor of pharmacology, Harvard Medical School, Boston.

Dr. Woods Hutchinson, New York City.

Dr. Holmes C. Jackson, professor of physiology, New York and Bellevue Medical College, New York City.

Dr. Philip Mills Jones, editor, *California State Medical Journal*, San Francisco.

Dr. George W. Jacoby, president, Neurological Society, New York City.

Dr. Theodore C. Janeway, professor of medicine, Johns Hopkins Medical School, Baltimore.

Dr. Frederic Kammerer, professor of clinical surgery, College of Physicians and Surgeons, New York City.

Dr. Frederic S. Lee, professor of physiology, Columbia University, New York City.

Dr. E. Libman, physician to Mt. Sinai Hospital, New York City.

Dr. Howard Lilienthal, surgeon to Mt. Sinai Hospital, New York City.

Dr. Warfield T. Longcope, professor of medicine, Columbia University, New York City.

Dr. F. J. Lutz, professor of clinical surgery, Washington University Medical School, St. Louis.

Dr. Hanau W. Loeb, dean, St. Louis University Medical School, St. Louis.

Dr. Walter Mendelson, trustee, Columbia University, New York City.

Dr. Rosalie S. Morton, New York City.

Dr. W. G. MacCallum, professor of pathology, Columbia University, New York City.

Dr. L. B. Mendel, professor of physiological chemistry, Sheffield Scientific School, New Haven.

Dr. Chas. H. Mayo, Rochester, Minn.

Dr. James F. McKernon, president, Post-graduate Medical School, New York City.

Dr. Joseph L. Miller, associate professor of medicine, Rush Medical College, Chicago.

Dr. Albert P. Mathews, professor of physiological chemistry, University of Chicago, Chicago.

Dr. Ward J. MacNeal, director, New York Post-graduate Hospital, Medical School, New York City.

Dr. F. G. Novy, professor of bacteriology, University of Michigan, Ann Arbor.

Dr. Albert J. Ochsner, professor of surgery, University of Illinois, Chicago.

Dr. G. M. Piersol, editor, *American Journal of the Medical Sciences*, Philadelphia.

Dr. W. M. Polk, director, Cornell University Medical School, New York City.

Dr. W. A. Pusey, professor of dermatology, University of Illinois, Chicago.

Dr. Stewart Paton, neurologist, Princeton, New Jersey.

Dr. Richard M. Pearce, professor of experimental medicine, University of Pennsylvania, Philadelphia.

Dr. Joseph H. Pratt, Harvard Medical School, Boston.

Dr. J. J. Putnam, professor of neurology, emeritus, Harvard Medical School, Boston.

Dr. Howell T. Pershing, professor of neurology, University of Colorado, Denver.

Dr. David Riesman, professor of clinical medicine, University of Pennsylvania, Philadelphia.

Dr. M. J. Rosenau, professor of preventive medicine, Harvard Medical School, Boston.

Dr. Beverley Robinson, professor of medicine, emeritus, University and Bellevue Medical School, New York City.

Dr. B. Sachs, neurologist, Mt. Sinai Hospital, New York City.

Dr. P. A. Shaffer, professor of biological chemistry, Washington University Medical School, St. Louis.

Dr. C. G. Stockton, professor of medicine, Buffalo Medical College, Buffalo.

Dr. Thomas L. Stedman, editor, *Medical Record*, New York City.

Dr. Torald Sollmann, professor of pharmacology, Western Reserve University, Cleveland.

Dr. Allen J. Smith, professor of pathology, dean, University of Pennsylvania, Philadelphia.

Dr. Winford H. Smith, superintendent, Johns Hopkins Hospital, Baltimore.

Dr. Frank F. Simpson, Pittsburgh, Pa.

Dr. W. T. Sedgwick, professor of biology, Massachusetts Institute of Technology, Boston.

Dr. Mabel Ulrich, Minneapolis, Minnesota.

Dr. Ap Morgan Vance, Louisville, Kentucky.

Dr. Martha Wollstein, associate, Rockefeller Institute, New York City.

Dr. George B. Wallace, professor of pharmacology, University and Bellevue Medical School, New York City.

Dr. J. Whitridge Williams, dean, Johns Hopkins Medical School, Baltimore.

Dr. J. C. Wilson, professor of medicine, emeritus, Jefferson Medical College, Philadelphia.

Dr. Hiram Woods, professor of ophthalmology, University of Maryland, Baltimore.

Dr. Jonathan Wright, New York City.

Dr. H. Gideon Wells, professor of pathology, University of Chicago, Chicago.

Dr. Ray L. Wilbur, professor of medicine, dean, Leland Stanford Junior University, San Francisco.

Dr. Richard Weil, assistant professor of experimental therapeutics, Cornell Medical School, New York City.

THE PRODUCTION OF RADIUM IN COLORADO

Secretary of the Interior Lane authorizes the statement that the production of radium from Colorado carnotite ores by the Bureau of Mines, in connection with the National Radium Institute, has passed the experimental stage in its new process and is now on a successful manufacturing basis. He says:

The cost of one gram of radium metal produced in the form of bromide during March, April and May of the present year was $36,050, I am informed by Dr. Charles L. Parsons, in charge of the radium investigations of the bureau. This includes the cost of ore, insurance, repairs, amortization allowance for plant and equipment, cost of Bureau of Mines cooperation, and all expenses incident to the production of high-grade radium bromide. When you consider that radium has been selling for $120,000 and $160,000 a gram, you will see just what the Bureau of Mines has accomplished along these lines.

The cost of producing radium in the small experimental plant during the first few months of the bureau's activities was somewhat higher but not enough to seriously effect the final average.

The public, however, should not infer that this low cost of production necessarily means an immediate drop in the selling price of radium. The National Radium Institute was fortunate in securing through the Crucible Steel Company the right to mine ten claims of carnotite ores belonging to them and this was practically the only ore available at the time. Since then new deposits have been opened but these are closely held and according to the best judgment of the experts employed by the Bureau of Mines the Colorado and Utah fields, which are much richer in radium-bearing ores than any others known, will supply ore for a few years only at the rate of production that obtained when the European war closed down the mines. The demand for radium will also increase rapidly, for the two or three surgeons who have a sufficient amount of this element to entitle them to speak from experience are obtaining results in the cure of cancer that are increasingly encouraging as their knowledge of its application improves. A few more reports like that presented to the American Medical Association at its recent San Francisco meeting and the medical profession, as a whole, will be convinced of its efficacy. Under all the circumstances that have come to my knowledge it does seem to me that it behooves the government to make some arrangement whereby these deposits, so unique in their extent and their richness, may be conserved in the truest sense for our people, by extracting the radium from the ores where it now lies useless and putting it to work for the eradication of cancer in the hospitals of the Army and Navy and the Public Health Service.

The ten carnotite claims being operated at Long Park, Colorado, by the National Radium Institute have already produced over 796 tons of ore averaging above two per cent. uranium oxide. The cost of ore delivered at the radium plant in Denver has averaged $81.30 per ton. This included 15 per cent. royalty, salary of Bureau of Mines employees, amortization of camp and equipment and all expenses incident to the mining, transportation, grinding and sampling of the ore.

A concentrating plant for low-grade ores has been erected at the mines and is successfully recovering material formerly wasted. Grinding and sampling machinery has been installed at Denver and a radium extraction plant erected in the same city. The radium plant has now a capacity of three tons of ore per day, having been more than doubled in size since last February. Before that time that plant had been run more or less on an experimental scale although regularly producing radium since June, 1914. To July 1, slightly over three grams of radium metal had been obtained in the form of radium barium sulfate containing over one milligram of radium to the kilogram of sulfates. The conversion of the sulfates into chlorides and the purification of the radium therefrom is easily accomplished and with very small loss of material. Unfortunately, however, special acid-proof enamel ware, obtainable only in France, has not been delivered of sufficient capacity to handle the crystallization of the full plant production, so that a little less than half the output, or to be exact, 1,304 milligrams of radium element have been delivered to the two hospitals connected with the National Radium Institute. The radium remaining can be crystallized at any time from neutral solution in apparatus already installed, but the greater rapidity and efficiency of production of this very valuable material by the methods used have decided the Bureau of Mines to await the completion of apparatus now being built before pushing the chloride crystallization to full capacity.

The average radium extraction of all ore mined by the National Radium Institute has been over 85 per cent. of the amount present in the ore as

determined by actual measurement. The amount present in the ore has been found in fact to be essentially the same as the theoretical amount required by the uranium-radium ratio. The extraction figures for the last five carloads of carnotite treatment has shown a recovery of over 90 per cent. in each case.

A bulletin giving details of mining, concentration and methods of extraction is being prepared by the Bureau of Mines and will be issued early in the fall.

SCIENTIFIC NOTES AND NEWS

DR. DAVID STARR JORDAN has been elected a member of the Royal Swedish Academy of Science at Stockholm, in appreciation of his work in zoology.

IT is planned at Brown University to collect a fund to endow the library of the department of mathematics in honor of Professor Nathaniel F. Davis, who will retire from active service at the close of the present academic year, after having served Brown University for over forty years.

THE University of Edinburgh has conferred the degree of doctor of laws on Professor W. A. Herdman, who holds the chair of zoology in the University of Liverpool, and on Professor Arthur Thomson, who holds the chair of human anatomy in the University of Oxford.

THE Royal Scottish Geographical Society has awarded the Livingstone gold medal to Lord Kitchener in recognition of his work on the survey of Palestine and as director of the survey of Cyprus, as well as in recognition of his services to the state. The society's gold medal has been awarded to Dr. J. Scott Keltie, late secretary of the Royal Geographical Society, in consideration of his services to geographical science.

THE medal and grant for 1915 of the South African Association for the Advancement of Science have been awarded to Mr. C. P. Lounsbury, chief of the division of entomology, Union Department of Agriculture.

THE following is a list of recently elected honorary fellows of the Royal Society of Medicine: *British:* Sir R. Douglas Powell, Lord Moulton, Sir John McFadyean, Sir Francis Darwin, Robert Bridges, Lieutenant-Colonel Sir David Prain, T. Pridgin Teale, Sir John Williams, Professor E. G. Browne, Professor S. G. Shattock. *Foreign:* Professors J. Babinski, A. Chauffard, Jules Dejerine, M. T. Tuffier of Paris, and Dr. Paul Heger, of Belgium.

THE Hanbury medal has been awarded to Mr. E. M. Holmes, curator of the Pharmaceutical Society's Museum, for his original research in the natural history of drugs.

ON June 30, as we learn from *Nature,* Dr. Alexander Fischer de Waldheim, director of the Imperial Botanic Garden of Peter the Great at Petrograd, completed the fiftieth year of his scientific and administrative activities. The event was made the occasion of a ceremony with presentation of addresses in the hall of the herbarium at the garden. Dr. Fischer de Waldheim commenced his botanical career as docent at the University of Moscow, and later became professor of botany at the University of Warsaw. On the death of A. F. Batalin in 1897 he was appointed director of the gardens at Petrograd.

THE committee on awards for scientific exhibits at the San Francisco meeting granted gold medals to the pathological departments of Stanford University and of the University of Michigan; to the Indiana State Board of Health, for its exhibit on a public health campaign; to Drs. C. C. Bass and F. M. Johns, of Tulane University, for their exhibit on pyorrhea alveolaris and malaria; to Drs. Claud A. Smith and J. Witherspoon, on hookworm; to the pathological laboratory of the New York Lying-in Hospital, on the demonstration of the cultivation of human tissue *in vitro;* to Dr. Martin H. Fischer, of Cincinnati, on newer experiments in the physiology and pathology of kidney functions, and to Dr. J. T. Case, of Battle Creek, on lantern slides illustrating Roentgen-ray studies.

THE bronze thesis medal of the Science Club of the University of Wisconsin was awarded at commencement to Walter Pitz for a thesis on "The Effect of Elemental Sulphur and of Calcium Sulphate on Certain of the Higher

and Lower Forms of Plant Life." This medal is awarded annually to a senior in the University of Wisconsin for quality and quantity of research in preparing a thesis in physical or natural science, or pure mathematics, or their useful applications.

DR. GOLDWATER, health commissioner of New York City, has resigned in order to resume his duties as superintendent of Mt. Sinai Hospital.

EDGAR M. LEDYARD, formerly assistant professor of entomology in the University of the Philippines, who has spent the last year in research work in the laboratory of parasitology of the University of California, has been appointed director of the Agricultural Department of the United States Smelting Company, Salt Lake City, Utah.

COLONEL WILLIAM HUNTER, M.D., assistant physician to Charing Cross Hospital; Lieutenant-Colonel G. S. Buchanan, M.D., first assistant medical officer to the local government board; Lieutenant-Colonel Andrew Balfour, C.M.G., director of the Wellcome Bureau of Scientific Research, and Lieutenant-Colonel Leonard Dudgeon, F.R.C.P., lecturer on general and special pathology at St. Thomas's Hospital, have gone to the Dardanelles, as an advisory committee to assist the British Royal Army Medical Corps in dealing with epidemics.

THE St. Louis University has fitted up an expedition to make a study of tropical diseases and biology in British and Spanish Honduras. The party which left New Orleans on July 21, was composed of the following: John P. Coony, Ph.D., S.J., professor of chemistry; E. N. Tobey, M.D., instructor in tropical diseases, and A. M. Schwitalla, S.J., A.M., a student in biology.

UNIVERSITY AND EDUCATIONAL NEWS

MR. C. W. DYSON PERRINS, who gave £5,000 toward the construction of the University of Oxford chemical laboratory which is nearing completion, has lately offered to present to the university a further sum of £25,000, of which £5,000 is to be applied to the equipment of the laboratory, and the remaining £20,000 is to form a permanent endowment fund for maintenance of the laboratory and for the encouragement of research and instruction in chemistry.

GEORGE PEABODY COLLEGE FOR TEACHERS has received $8,500 from Miss Eleanor Cuyler of New York City and Mr. Thos. DeWitt Cuyler of Philadelphia, for equipping the Jesup Psychology Laboratory. This amount of money is to be spent for furniture, laboratory equipment and psychological publications.

PROFESSOR H. S. JACKSON, of the Oregon Agricultural College, has accepted the position of head of the botanical department of the Agricultural Experiment Station of Purdue University, Lafayette, Indiana, to take effect September first, as successor to Dr. J. C. Arthur, who retires as a beneficiary of the Carnegie Foundation for the Advancement of Teaching.

DR. E. W. SINNOTT, of the Bussey Institution, has been appointed professor of botany and genetics at the Connecticut Agricultural College.

AT Yale University, Reynold A. Spaeth, Ph.D. (Harvard, '13), instructor in embryology at Clark University, has been appointed instructor in biology in Yale College.

THE following appointments have been made at the Massachusetts Institute of Technology: George Owen (M. I. T., '94), assistant professor of naval architecture; Royal M. Frye, A.B., instructor in physics; Charles H. Calder, Horatio W. Lamson and Joseph C. MacKinnon, assistants in physics; Elwyn E. Snyder, Jr., assistant in industrial chemistry.

AT Rutgers College research assistants have been appointed as follows:

Roland E. Curtis, B.S. (Oregon), soil bacteriology.
F. E. Allison, B.S. (Purdue), M.S. (Iowa State), Amos Phos fellow.
Selman A. Waksman, B.S. (Rutgers), soil bacteriology.
Carl R. Fellers, B.S. (Cornell), soy bean.
William S. Porte, B.S. (Rutgers), plant physiology.
Orville Schultz, B.S. (Iowa State), plant breeding.
W. H. Martin, B.S. (Maine), plant pathology.
W. S. Krout, B.S., M.A. (Ohio State), plant pathology.
Homer E. Carney, B.S. (Miami), botany.

A. C. Foster, B.S. (Alabama Polytechnic), botany.
Franklin O. Church, B.S. (Rutgers), hydraulic engineering.
F. P. Schlatter, B.S. (Pennsylvania State), cranberry investigations.

Dr. Francis Arthur Bainbridge, of the University of Durham, has been appointed to the University of London chair of physiology tenable at St. Bartholomew's Hospital Medical School.

DISCUSSION AND CORRESPONDENCE

LOSING THE ADVANTAGES OF THE BINOMIAL SYSTEM OF NOMENCLATURE

The communication from Dr. F. B. Sumner which appeared in Science for June 18 last on the subject of saving the genus as a category of zoological classification, is certainly a timely one, and expresses views that are by no means confined to its author. It will require but little examination of the facts to lead to the conclusion that not the enforcement of the law of priority, but unrestricted splitting of genera, is responsible for most of the confusion and instability which characterize zoological nomenclature to-day, and makes it a source of inconvenience and uncertainty, demanding from scientific men much profitless labor, and expenditure of mental energy sufficient to bring about important advances in science if it could be turned into some useful channel.

Few zoologists ever stop to think how far we are getting away from a real binomial system of nomenclature. It is true that scientific names of animals still consist of two words, but only in a minority of cases does the first term of the binomial have any real meaning to us, or suggest ideas of a much broader and more comprehensive character than the second one. The genus name has become little more than a mere prefix to, or part of, the species name. The addition of a few more letters or syllables to the latter (to prevent confusion of organisms which have chanced to receive the same specific designation) would serve the same purpose. We learn generic names, if we learn them at all, by mere acts of memory, and we use them because we find them in the latest monographs and might be thought not up to date if we did otherwise, but what the distinctions are between these multitudes of closely allied genera we rarely stop to inquire. Indeed, if we do have interest enough to look up such points, the slight importance and complexity of the distinctions are apt to surprise and discourage us, and convince us that we had better take the specialist's word for them, and spend our time and labor in some more useful way. In short, though our classification is binomial in form, it is only very imperfectly so in effect.

Even within the memory of some scientific men living to-day, the system in use did still afford the practical advantages which secured the universal adoption of the system of Linnæus. The recognized genera, though even then being multiplied to an inconvenient extent, were still in a majority of cases separated by sufficiently well-marked characters and not as yet too numerous to enable the professional zoologist and even the more serious amateur students of the science to recognize by name and classify a large proportion of the genera, and to recall some of their more important characters. A genus name had in those days a real meaning to some others besides the specialists in the class of animals to which the genus happened to belong.

It would be a mistake to maintain that zoological classification has suffered through the recognition of these minor subdivisions. They exist in nature, and should have a recognition commensurate with their importance. The older and more comprehensive genera are now in many cases treated as subfamilies or families. Classification has gained in exactness and truthful representation of the facts, but through our neglect to keep the first term of our scientific names comprehensive in its application, and easily distinguished and remembered in its meaning, we have allowed our nomenclature to lose most of the practical advantages and conveniences of the Linnæan system.

Unfortunately, specialists, as Dr. Sumner has hinted, are only too apt to study their specimens till they see only differences and lose sight of much more important resemblances,

and hence to commit in their own works the offenses that they find fault with in the works of other authors. They should sometimes endeavor to look upon their subject from the point of view of the general zoologist, and get a more correct perspective of the relative importance of characters than can be obtained if their ideas run too much within the narrow limits to which the study of restricted groups tends to confine them. If specialists will take the lead in reducing to subgenera or sections many of the genera now recognized, other zoologists will be only too glad to follow them. Such a course would not for a moment require the abandonment of those genera as divisions of classification, nor necessarily indicate the admission of any change of view as to their intrinsic importance; it would be merely a question to be decided on the basis of obtaining a nomenclature practical for zoologists in general. As it is now, our nomenclature is adapted for specialists only, and for each specialist only for his own particular field of study. As far as the rest of the animal kingdom is concerned, he is in the same position as a general student of zoology, and finds the existing nomenclature as inconvenient as every one else does.

One common practise seems to be especially illogical. That is the attempt to break up well-defined genera simply because they contain a large number of species. Such genera exist in nature, as well as many genera with a few or with but one species, and this must be the case in our classification also if it is to be true to nature. It is claimed that large genera are "inconvenient," but in such cases the inconvenience is not in the classification, but in nature itself, which has evolved a large assemblage of closely allied forms, and it is often made worse rather than better by the attempt to distinguish genera which have no real dividing limits.

The writer is inclined to question whether Dr. Sumner has gone quite far enough in recommending subgenera as substitutes for many of our present genera. Some of the latter hardly deserve even that low rank. A subgenus receives a scientific name of the same form as a genus name, and affords a standing temptation for the next specialist who makes a more minute division, to treat it as a genus, thereby changing the scientific names of all the species involved. Even if this never happens, scientific literature is burdened with a new technical name which adds its weight to the already excessively large proportion of zoological subject-matter which consists of mere names of things, in distinction to real knowledge about animals. Names and technical words we must have, but whether we do it consciously or not, we use mental energy in learning and remembering and using them, or in looking them up in books. If neither necessity nor frequent and general usefulness justifies their existence they should be done away with, or, better still, never coined. The best carpenter or machinist neither needs nor desires the largest possible set of tools, and hesitates to encumber himself with extra ones which he has no real need of, and science would probably be as well off with fewer technical words.

A method that has often been used and proved a satisfactory one for naming unimportant groups is that of designating them by their best known or first described species. Such a system has been applied to the minor divisions of large genera, as *Unio*, by Simpson in his well-known synopsis of the Naiades, where he speaks of the "group of *Unio gibbosus*," "the group of *Unio littoralis*," etc. Not only are no new words coined, but to those with some familiarity with the genera in question the groups are better understood than if they were called by some arbitrarily formed and no less arbitrarily applied combinations of Greek or Latin roots and suffixes. Simpson used this method only for assemblages of very nearly allied species, but it might well be extended to many groups now treated as genera or subgenera.

If instead of coining new technical words, simple and logically formed combinations of more or less familiar ones were more generally employed, we would be saved the necessity of learning and remembering, looking up and explaining hundreds if not thousands of needless words and names, and have a correspond-

ingly greater part of our time left for acquiring and employing really useful knowledge, and the purposes and results of scientific investigation would be understood and appreciated by a larger part of the public than is now the case.

Willard G. Van Name
New York State Museum

AMERICAN SANITATION

To the Editor of Science: The writer has just finished reading Dr. Ford's most interesting article on "American Sanitation," in your issue of July 2, and wishes to endorse heartily the plea therein contained for more extensive and better training in public health. The writer feels, however, that he must differ with Dr. Ford as to the wisdom of excluding all but physicians from participation in health work. Dr. Ford evidently assumes that there is no essential difference between community hygiene and personal hygiene, and that a thorough medical training, with its time-consuming studies of anatomy, histology, obstetrics, materia medica, etc., is essential before undertaking special work along the lines of sanitation, or the protection of the community from disease.

The present writer holds no brief for the ordinary engineer in positions of high responsibility in general health work, but he can not help feeling that a well-trained sanitary engineer would distinguish his incumbency of the health officership of a town, about as well as an eye and ear specialist would do. In fact, the chances are that neither would be conspicuously successful.

The ideal health officer should be neither an M.D. nor a C.E. but should be an expert in community hygiene, such expertness combining a knowledge of both branches (and some others). It should be possible for a young man desirous of entering the field of public health to secure training for that service without being compelled to undertake the study of a great many medical subjects which have to do with curative rather than with preventive medicine; and also without having to learn about highways, railways and framed structures. He should, upon completion of such a course of training, be thoroughly conversant with the causation and transmission of disease; and have enough engineering training to enable him to look upon problems in municipal sanitation with that sense of perspective which is found more highly developed among civil engineers than among physicians.

An amusing story illustrating that lack of quantitative appreciation, or perspective is vouched for by one of the writer's professional friends. A practising physician in one of our large cities sent a communication to the health commissioner in which he recommended the addition of some mild laxative to the city water to counteract the baleful effects of the coagulants applied previous to filtration. Of course, it is to be understood that this is recognized as an extreme case, but in the course of ten years' experience as a sanitary engineer, the writer has heard many decidedly puerile things said by physicians who pretended to some knowledge of sanitation.

Wm. T. Carpenter
Brooklyn Sewage Disposal
Experimental Station

ANIMAL MALFORMATIONS

To the Editor of Science: Referring to the communication on "a chicken with four legs" in Science, page 90, I would say, lest the malformation should be considered rare, that we have in this museum quite a number, fourteen from the chicken alone, showing various degrees of the malformation; also from the duck and turkey, and from some higher animals as the dog, pig and kitten. Technically the malformation is known as dipygus or preferably as dipygus parasiticus.

D. S. Lamb
U. S. Army Medical Museum,
Washington, D. C.

THE LONG COST OF WAR

To the Editor of Science: The writer is interested in gathering material bearing on the eugenics of war and militarism. It is obvious that these influences tend to weaken a nation through the destruction of those physically the best and through the debarring of

the soldier from honorable parenthood. In addition to abundant records from Europe and America, we have the following facts from Japan.

The war between China and Japan occurred twenty years ago. It involved the destruction of a large number of picked men of Japan and a corresponding reduction in the virility of the nation. The effects of the loss on the succeeding generation can not be felt until the children born in 1895 attain their majority. These results can be measured only in the reduced stature of the incoming conscripts and in the proportion of exemptions from military service. "Like the seed is the harvest." The new generation takes the quality of those men and women who were its actual parents. Those whom war has destroyed, in general the stronger and the best developed physically, are not represented.

According to the *Asahi* of Tokyo, as translated in the *Japan Chronicle,* the number of available conscripts in Tokyo for this year is 9,235, instead of 9,981. For a number of years there had been a steady increase of about 800. This falling off of 1,546 marks a decrease of over 16 per cent. In Kanda, the most densely populated ward of Tokyo, the decrease was 22 per cent.

In the whole nation, a slight increase of conscripts has taken place, 482,965 as against 472,147 of 1914. But this rate of increase (9,000) is only from thirty to fifty per cent. of the normal, which for years has ranged from 20,000 to 30,000.

More important than the reduction in numbers is the lowering in quality. In Kanda in 1914, twenty-four per cent. of the conscripts were passed as "strong," while in 1915, the percentage was thirteen per cent. (83 out of 635, instead of 194 out of 813). A much larger percentage of those sent to the barracks were of the "average" class.

The birth-rate in Japan, as in every other nation, declined in time of war, to rise again at its conclusion.

This decline of physique is a matter of concern to the military authorities of Japan, but they optimistically hope that it is of a temporary nature. The *Asahi* concludes that "most of those who underwent conscript examinations this year were born during the war and therefore are sons of those too old or too weak to go to the front, and so it is no surprising thing if the conscripts of 1915 are of exceptionally delicate constitution."

David Starr Jordan

July 24, 1915

SCIENTIFIC BOOKS

Key to the Families of North American Insects. By Charles T. Brues and A. L. Melander. Boston, Mass., and Pullman, Wash., published by the authors, 1915.

Most modern works on entomology contain keys or tabular synopses, intended to facilitate the determination of families, genera and species. It is the experience of those who have classes in entomology that these keys are on the whole unsatisfactory, being frequently incomplete, incorrect or unintelligible. The most noteworthy exception is found in Williston's "Manual of North American Diptera" (1908), which, considering its scope, could hardly be improved. One who has constantly used Williston's book for a number of years becomes convinced that it is possible to prepare keys which will in nearly every case enable the student to determine the genus of the insect before him, especially when he has also the aid of numerous outline figures. It is really astonishing how soon a clever student will learn to use works of this kind; at Boulder we find that students using an illustrated table of Rocky Mountain bees can frequently determine correctly as many as four genera in an hour, in spite of the fact that the insects and the kind of work are new to them. Exceptional students do even better than this.

The method having proved so satisfactory, Professors Brues and Melander thought it worth while to prepare a key to all the families of North American insects, illustrated, like Williston's book, with many outline figures. Thus we have for the first time a complete synopsis of the families, whereby the student may find the place in the taxonomic system of

any insect he happens to have obtained. In preparing this key, the authors have taken advantage of all previous work which appeared serviceable, added to their own extensive knowledge of a number of groups, so the result is probably not far from the best attainable in the present state of our knowledge. The book will be invaluable to all students of entomology, and will be in constant use in every entomological laboratory. The details of insect classification are not so well established that it is possible to present a system which will be universally approved. In the present case we recognize a number of improvements over arrangements previously current, but we must protest against the uncritical adoption of the system of Handlirsch. It is actually proposed to recognize five classes of insects, the additional four being made out of the Aptera, one of them containing the recently discovered Protura. Then, again, the old order Orthoptera is divided into a long series of orders, placed in two subclasses. The reviewer has not critically reconsidered the whole subject to determine exactly what support may be found for all these changes, but neither has any one else in this country, so far as we know, for it would involve many months or years of intensive labor, with access to very large collections. The reviewer has however had much occasion to use Handlirsch's great work "Die fossilen Insekten," in which the new classification appears, and has come to a clear estimate of its merits and faults. It is a wonderful compilation, showing enormous industry and great ability, and will always rank as a classic in the literature of entomology; but in detail, and especially in its innovations, it is not to be trusted, the taxonomic arrangements set forth with so much assurance being often based on very inadequate grounds or imperfect knowledge. It may well be that this author has been taken more seriously than he himself intended. A new classification, even if faulty, is of value if it stimulates thought and is received in a critical though friendly spirit; to adopt it *en bloc* without criticism is in a sense to do an injustice to the eminent author.

Only frequent use will show how serviceable the key is in all its details. Undoubtedly many little changes will be required in the next edition. As the authors observe, the families are not of equal rank, and it seems impracticable to make them so. All the scale insects and mealy-bugs are still Coccidæ, all the ants are called Formicidæ, while the bees are divided into twelve families.

T. D. A. Cockerell
University of Colorado

ON THE ACOUSTICS OF THE CHAPEL OF ADELBERT COLLEGE

In Science of November 14, 1913, was published a short account of experiments made to determine the effect of a sounding board on the acoustic qualities of the chapel of Adelbert College. The sounding board, constructed at the suggestion of the architect of the building, and in accordance with his specifications, was of the canopy type, about six feet in diameter, and suspended about two feet above the head of the speaker. An investigation showed, as was not unexpected, that the sounding board was without noticeable effect, and it became necessary to try other remedies.

A sufficiently detailed description of the interior of the chapel is given in the previous article, and need not be repeated. The ceiling of the building is of wood, the walls are in part of stone, and in part of plaster laid directly upon the stone without lath or furring.

There was no evidence, as was before stated, of special or local echoes. The difficulty was plainly one of excessive reverberation, due to the insufficient absorbing power of the walls and ceiling. It was evident that the only effective remedy was to cover a portion of the walls with highly absorbent material, after the manner devised by Professor Sabine, of Harvard University. The generosity of the donors of the chapel provided the necessary means; the work was intrusted to an "acoustic engineer," a former student of Professor Sabine's, and Mr. Sabine himself was good enough to aid with counsel and suggestion.

Calculation showed that a reasonably effective treatment might be obtained by covering the ceiling and the upper part of the walls

down to the springing of the window arches with a specially prepared felt.

The felt as actually applied was two inches thick on the ceiling, one inch thick on the side walls. The work was carried out with admirable efficiency and carefulness. The appearance of the chapel was practically unchanged, so that no one, unaware of the treatment, would have guessed that any application of the kind had been made.

Experiments extending over one college year were made to test the effectiveness of the arrangement.

A college chapel service, where attendance is required, affords a unique opportunity for a study of this kind. Five regular services weekly are held in the Adelbert College chapel. One of these is a musical service; the other four generally include a short address on some practical or ethical subject. The services are conducted by a number of clergymen from the city, each of whom officiates in general all the four days in a given week. It is possible, therefore, for an observer to listen to the same speaker for four successive days. The audience is practically the same each day, and the general conditions are nearly constant, so that the observations made on successive days are comparable to a satisfactory degree.

The experiments consisted simply in listening to a speaker on successive days, from different parts of the auditorium, and noting down in each case the percentage of the words spoken which were clearly understood. Effort was made to consider only words which were definitely heard, excluding as far as might be those gained by association from the context. Previous experiments, in connection with the sounding-board, had given some facility in this kind of work. Of course, only a rough approximation is possible, yet the margin of error is perhaps less than would be at first supposed. The attention is fixed, not on the number of words understood, but on the number missed. It is easy to distinguish approximately between the loss of one word in five, one in ten, one in twenty; these correspond to an audibility of 80, 90 and 95 per cent., respectively. 95 per cent. means excellent hearing, 90 per cent. is fair, but if the number of words heard is only 80 per cent. of the whole, the hearing is positively poor, and below this runs rapidly into unintelligibility. Perfectly satisfactory hearing, clear and sharp, without effort or close attention, is rated at 100 per cent.

Four seats were chosen as places of observation, one in the front row of the gallery at the back of the chapel, perhaps ninety-five feet from the pulpit where the speaker stood, three on the floor, seat AA, immediately under the front edge of the gallery, about ninety feet from the speaker, seats V and Q, respectively seventy-five and fifty-five feet from the speaker. The observer sat on successive days in each of these seats in rotation, making notes as suggested above.

The chapel was treated with the absorbent felt during the summer vacation of 1914. The experiments began in February, 1914, while the chapel was in its original condition, while the second set, after the treatment of the walls, extended from the latter part of September, 1914, to the end of February, 1915, the whole including two college semesters.

The relative number of words heard in the case of each speaker having been evaluated as closely as possible, the results were averaged for each position of the hearer. For example, in the seat AA, ninety feet from the speaker, 25 experiments were made during the first semester, varying in intelligibility from 10 per cent. to 95 per cent. The average of all the speakers was 71 per cent. This means that on the average more than one word in four was missed by the hearer. In almost every case the necessary attention was recorded as "careful" or "strained." Listening was wearisome, and it was often impossible to follow intelligently the purport of the address.

In the second semester, sitting in the same position, 28 speakers were heard. The average audibility was 91 per cent. The attention given was recorded as "easy" in about half the cases, as "careful" in the others. In no case was a tense or strained attention needful.

The improvement in hearing was greatest, of course, in the case of those who were heard with difficulty, though in all cases the gain was

marked. One speaker in particular, as the result of several hearings, in the first half-year was rated at 10 per cent., in the second at 76 per cent.

Of the different speakers, six were heard in both of the semesters, and are thus more directly comparable than the others. Their average for the first semester was 64 per cent., for the second, 92 per cent., that is, while during the first semester more than one word out of every three was unintelligible, only about one in twelve was unheard in the second.

The effect was even more striking in seat V. Before the treatment of the chapel the average audibility was 71 per cent., exactly the same as at the greater distance, showing that the advantage gained by a somewhat nearer approach to the speaker was completely nullified by the disturbances from reverberation. The attention, as in the seat AA, was careful or strained. After the treatment the average audibility rose to nearly 96 per cent., nearly perfect hearing, and the attention in most cases was noted as easy.

In seat Q, about fifty-five feet from the speaker, the audibility rose from an average of 95 per cent. in the first semester to 100 per cent. in each separate case in the second.

The results are summarized below for more easy comparison.

AVERAGE OF ALL SPEAKERS

Seat	First Semester. Per Cent.	Second Semester. Per Cent.
AA	71	91
V	71	96
Q	95	100

The seat in the gallery gave exactly similar results, but the number of experiments made in this seat was so small that the averages are not included in the table.

The condition of the auditorium at present is satisfactory. It is quite possible that a slight further reduction of reverberation might be made with advantage to the spoken word, but the effect of music, which forms an important part of the uses of the building, would be correspondingly injured.

It may be worth while further to remark that the calculations as to the effect of reverberation could have been as well made, plan and materials being given, before the erection of the building as afterward. It is a pity that architects still construct buildings of this kind without giving careful attention to their expected uses, trusting to good fortune for acoustic fitness which might easily and certainly be insured in advance.

FRANK P. WHITMAN
PHYSICAL LABORATORY,
WESTERN RESERVE UNIVERSITY

SPECIAL ARTICLES

TWO COLOR MUTATIONS OF RATS WHICH SHOW PARTIAL COUPLING

IN the *American Naturalist* for February, 1914, Castle described two yellow-coated varieties of the Norway rat (*Mus norvegicus*) which had recently been discovered in England, and both of which had been found to behave as Mendelian recessive characters in heredity. One of these was called "pink-eyed yellow," the other "black-eyed yellow." A more appropriate name for the latter would be "red-eyed yellow" (which we shall hereafter use), since the eyes in this variety are not as dark as in wild gray or tame black rats, but the red blood of the eye shows through, particularly when the animal is young, giving the eye in a favorable light a reddish tinge.

Upon crossing the two yellow varieties with each other, we found them to be complementary. The F_1 young obtained were none of them yellow, but were all either gray or black coated; yet it should be noted that they were in no case as dark as ordinary gray or black rats. Nevertheless F_2 young with coats of normal intensity were later obtained, so that the paleness of the F_1 young was evidently due rather to their being heterozygous for the two complementary factors, than to any failure of one variation completely to supply what was lacking in the other.

Each of the yellow varieties was also found to be different in nature from ordinary albinism, as seen in white rats, since when it was crossed with albinos it produced only fully

pigmented (gray or black) rats, which when crossed with each other produced an F_2 generation consisting of approximately 9 gray or black rats to 3 yellows, and 4 albinos, a typical dihybrid result.

But the most interesting aspect of the two yellow variations is their apparent "negative coupling" or mutual "repulsion," a phenomenon first discovered by Bateson and Punnett in plants, but since observed in insects by Morgan and Tanaka. This repulsion, in the case of the two yellow variations of rats, is incomplete, as is true in most recorded cases of repulsion, and it indicates, if we adopt Morgan's manner of explaining it, a location near together in the germ-plasm of the respective determiners or "genes" for red-eyed and for pink-eyed yellow.

The evidence for this partial repulsion is as follows: When the F_1 gray or black rats, obtained by intercrossing the yellow varieties, were themselves intercrossed, they produced an F_2 generation which contained 102 gray or black young, 55 red-eyed yellows, and 43 pink-eyed yellows.

To ascertain the gametic composition of the yellow F_2 animals, (1) the extracted red-eyed yellows were mated with yellows of the pure pink-eyed race, and (2) the extracted pink-eyed yellows were mated with pure red-eyed yellows. Twenty-eight test matings of the first sort have been made and twenty-seven of the second sort, with the following results.

In 20 matings, extracted red-eyed yellows mated with pure pink-eyed yellows have produced only black-eyed young (grays or blacks), while in the remaining 8 matings both black-eyed young (grays or blacks) and pink-eyed young have been produced. The red-eyed parent, in the former type of mating, must have lacked altogether the gene for pink-eye, while in the latter type of mating it must have been heterozygous for pink-eye. If we designate the (recessive) gene for red-eye by r and the (likewise recessive) gene for pink-eye by p, then the F_2 red-eyed yellows tested must evidently have been of the two types rr (20 cases) and rrp (8 cases), respectively. The former type, when mated with pure pink-eyed animals (pp), would produce only double heterozygotes (pr), whereas the latter would produce either double heterozygotes (pr) or homozygous pinks heterozygous for red-eye (ppr). On the theory of probability, if red-eye and pink-eye are produced by wholly independent genes, we should expect animals of the former type to be only half as common as animals of the latter type in a population of extracted (F_2) red-eyed yellows, *but observation shows them in this case to be more than twice as common!* Hence there is a strong presumption that red-eye and pink-eye depend upon genes not wholly unconnected with each other. This presumption is strengthened by the results obtained by testing the extracted F_2 pink-eyed yellows by mating them with pure red-eyed yellows. Twenty-seven such animals were tested, of which 19 produced only black-eyed young (grays or blacks), while 6 produced both black-eyed (gray or black coated) and red-eyed (yellow) young, and 2 others produced only red-eyed (yellow) young.

All the pink-eyed F_2 animals tested must have been homozygous for pink-eye (otherwise they would not have shown pink-eye), but as regards the possession of red-eye it is evident that conceivably they might (1) lack it altogether, (2) be heterozygous for it, or (3) might be homozygous for it, conditions which would be expressed by the formulæ pp, ppr and $pprr$, respectively. Animals of the first sort (pp), if mated with pure red-eyed animals, should produce only black-eyed young (grays or blacks, the observed result in 19 cases); animals of the second sort (ppr) should produce some young black-eyed and others red-eyed (the observed result in 6 cases); animals of the third sort ($pprr$) should produce only red-eyed yellow young, an expectation realized in 2 cases. The chance expectations for the occurrence of these three sorts of results are as 1:2:1; the observed occurrences are widely different, viz., 20:6:2.

If the repulsion between the two yellow variations were complete, no F_2 individuals of classes 2 and 3 (ppr and $pprr$) would be formed, but all F_2 pink-eyed yellows would be of class 1 (pp). The fact that classes 2 and 3 are

formed but are much *smaller* than expected shows that *partial* repulsion exists between the two yellow variations. In the origin of the 55 yellow rats which have been tested, 110 gametes were involved. Inspection of the results shows that in 92 of these gametes the factors for red-eye and pink-eye remained apart, as they were originally; but in 18 of them a cross-over must have occurred producing a gamete which contained both factors. This ratio of 92 unchanged to 18 cross-over gametes (or 5.1 to 1) among the gametes which produced the yellow rats, should give nearly, though not quite, the gametic ratio among *all gametes* produced by the F_1 rats. This true gametic ratio may be shown by the foregoing figures to be about 4.6 to 1 and the per cent. of cross-overs to be about 18.

Animals of class 3 (*pprr*), homozygous for both kinds of yellow, should produce gametes in which these two characters would show positive coupling instead of repulsion. This matter is now being investigated with the idea of finding a quantitative expression for the strength of the coupling and comparing it with the strength of the repulsion already demonstrated.

W. E. Castle,
Sewall Wright

Bussey Institution,
June 28, 1915

TOXICITY AND MALNUTRITION[1]

The concept denoted by the word "toxicity" contains an element essentially physiological in its nature and describes primarily not so much a chemical property of a given substance as the result of a chemical reaction of this substance with one or more constituents of a given organism. Thus the effects produced by the chemical substance on the organism are obviously due to the chemical properties both of the substance itself and of the tissues of the organism. Hence, while derived in part from the chemical properties of the substance, toxicity does not exist apart from the organism and can be asserted of any given substance only after fitting experiments have been carried out on the organism in question. In contrast to this property, the purely chemical properties, such as acidity or alkalinity, exist apart from any relation to the organism. When a given chemical substance possessed of specific properties comes in contact with an organism which of course is essentially made up of substances having likewise definite chemical properties, the reactions which follow in accordance with the laws governing chemical behavior are capable of description by means of chemical terms, but from the standpoint of the organism a physiological result has occurred defined not in terms of ions and molecules, but in terms of function. When, as a result of the chemical reaction, the organism is so modified as to cause the non-performance or imperfect performance of function a more or less marked physiological injury is recognized. If the injury involves sufficiently important functions and the reaction is irreversible, death results. Should functional activity be impaired only in nonessential particulars or should the reaction be reversed, life may persist in spite of permanent injury or recovery may take place. If the arrest or derangement of function is sufficiently thorough and prompt, the organism is said, in popular phrase, to be "poisoned" and the chemical substance entering into the disturbing reaction is said to be a "toxic" substance. In view of these considerations there seems to be no scientific ground for limiting the term "toxicity" to the popular conception.

"Toxicity" results in functional impairment due to chemical reaction and, accurately speaking, is more a matter of kind than of degree. If this impairment proceeds to the point of death there might seem to be a basis for distinction between this result and that of a less serious injury not so terminating. However, if death takes place indirectly and remotely through secondary changes initiated by the chemical reaction, the organism would still have been "poisoned." If functional injury, however slight and remote, should follow from the chemical reaction, it would still be in kind a "toxic" action.

[1] Published by permission of the Secretary of Agriculture.

The terms "toxic" and "poisonous," as used popularly in characterizing chemical substances, are subject to still another consideration. Substances like corrosive sublimate, copper salts, hydrochloric acid and phenol, are popularly called "toxic" substances because, in concentrations familiarly used, they produce such marked chemical reactions in organisms as to cause serious impairment of function and perhaps death. It should be borne in mind, however, that these substances lose their ability to act toxically on sufficient dilution, and even the so-called harmless chemical agents when sufficiently concentrated, if still soluble, become harmful. The question of toxic action, therefore, comes down finally not only to a matter of the chemical properties of substances, but equally to a question of the concentration of the solution in which they encounter the organism. It would follow that perhaps all substances acting singly are potentially toxic.

It might seem that water, at least, would escape the suspicion of being "poisonous." Of course, pure water is practically unknown to biology and little can be asserted concerning its action on organisms. When this substance is referred to, distilled water, a dilute solution of various substances, is usually meant. The work of a host of investigators on distilled water has led to a great variety of results, a fact due on the one hand, doubtless, to the great variation in the water used, and, on the other, to the varying susceptibility of the experimental organisms employed. It has, however, been repeatedly shown that very minute traces of salts are able to profoundly modify the physiological properties characteristic of highly purified water.

It has been shown that distilled water withdraws small quantities of electrolytes from various organisms of both plant and animal origin, with the result that as this process advances, the water becomes an increasingly concentrated solution of ions. The ability of *Fundulus* eggs to resist the action characteristic of water rendered in a scientific sense even approximately pure, as claimed by Loeb, seems to be very unusual. It would be of interest to know accurately what the ion concentration of the distilled water used in these investigations might have been at the beginning of the experiment and after it had been occupied by the *Fundulus* eggs.

If toxicity is indicated by functional derangement due to chemical reactions, then clearly nothing can be toxic in its action that can not produce chemical change in the organism. In other words, mere absence can not furnish a ground for charges of toxicity against any substance. If the solution from which a necessary substance is lacking causes the development of toxic properties (*i. e.*, functional derangement due to chemical modifications produced in the organism by the external medium) the reaction causing the derangement must proceed from the substances in position to affect the organism. Hence, incomplete nutrient media or unbalanced solutions, both producing functional derangement, bring about this effect through the reactions performed by the substances present, certainly not by those not present. Perhaps the most satisfactory approach to the situation is seen through the relation supposed by Loeb and others to exist between ions and proteins in the living organism. For normal functioning certain affinities in the proteins of the organism must be occupied by certain ions in a rather definite way. When one such ion is lacking to the medium, the affinities normally occupied by it are satisfied in a chemical way by ions present without, however, satisfying the corresponding physiological requirement. While, therefore, the absence of a necessary ion gives the opportunity for the harm-bringing reaction to take place, the actual damage is wrought within the cell by constituents actually there present. Thus, a medium characterized as deficient or unbalanced becomes actively injurious through the effects produced by the ions that are present, and malnutrition, starvation, or even a more violent type of chemical injury may appear.

Rodney H. True

Bureau of Plant Industry,
U. S. Department of Agriculture

SCIENCE

FRIDAY, AUGUST 13, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RISE OF NATURAL HISTORY MUSEUMS[1]

WHENCE they come and whither they go are inquiries that should be made from time to time by all institutions in order that they may profit by the experiences of the past and survey the way of the future. Owing to obvious limitations, I shall attempt to sketch the growth of but a single division of the museums represented in this association, leaving to others the rounding out of the inquiry if it shall ever seem to them desirable to do so.

A desire to preserve objects of nature which aroused special interest or possessed unusual powers may be presumed to have been an instinct of the earliest man. We may imagine the cave man storing in his cave the bright gem, or curious seed, or rare animal skin which attracted his attention and, perchance, urging upon his descendants the desirability of preserving it. Such instincts are undoubtedly possessed by barbarous tribes. But such hoards have no permanent value or maintenance as long as there is a lack of a fixed habitation or of a social organization sufficiently strong to pass them from one generation to another. Hence, it may be noted in passing, an essential condition for the existence of museums is a sufficiently civilized and permanent state of society to preserve objects from generation to generation.

In the life of the ancient Egyptians conditions making toward the preservation of natural objects doubtless became more favorable than had previously been the

[1] Presidential address read at the meeting of the American Association of Museums, San Francisco.

case, since there are preserved to us from their time many objects of their art which were originally objects of nature. While material which they prized now occupies an honored place in our museums and their civilization was instrumental in preserving it to us, there is no evidence, so far as I know, that they undertook the collection and preservation of natural objects for their own sake.

The Greeks gave us the word *museum*, but that they ever established a museum in the modern sense seems very unlikely. Whatever their practise may have been regarding the preservation and exhibition of works of art, it seems quite certain that they carried on little, if any, effort of this kind with regard to nature. Alexander the Great, about 325 B.C., is said to have gathered together many animals and plants in order that they might be studied by Aristotle, "the father of natural history," but so far as we know no effort was made to preserve these specimens to later times. The first record of placing natural history specimens on exhibition is said to be that made when Hanno, a Carthaginian, somewhat before Alexander's time, procured skins of gorillas in Africa and put them in the temple of Astarte. We also know that the monstrous horns of wild bulls which had occasioned great devastation in Macedonia were hung in the temple of Hercules by order of King Philip.

The Romans seem, like the Greeks, not to have taken much interest in the preservation of natural objects, at least as far as any record has reached the present time. We know that emperors and other individuals possessed collections of statues and other works of art, and among these we find occasional mention of the preservation of so-called "natural curiosities," such as bones of giants or peculiar human skeletons, but that any broad interest in nature existed which led to efforts to preserve and study its forms we have no record. Stray sources of information tell us of a crocodile, found in attempting to discover the sources of the Nile, being preserved in the temple of Isis at Cesarea, also that a large piece of the root of the cinnamon tree was kept in a golden vessel in one of the temples at Rome. Pliny relates that the bones of a sea monster, probably a whale, "to which Andromeda was exposed," were preserved at Joppa and afterwards brought to Rome. Suetonious says that the Emperor Augustus had a collection of natural curiosities in his palace.

One reason suggested by Beckmann for the rarity of collections of natural objects among ancient peoples was the lack of knowledge of satisfactory means of preserving such as were perishable. The preservative virtues of what was then called "spirit of wine," but which we now know as alcohol, seem to have been but little known, and only immersion in salt brine or a covering with wax or honey served at that time for the preservation of perishable materials.

The great institute of Alexandria in Egypt, founded in the third century B.C., is generally spoken of as being the first natural-history museum of antiquity, but while this had botanical and zoological gardens, there is little reason to suppose that it was a museum of nature in the modern sense. The name museum in that institution was applied to a portion set apart for the study of sciences, and indicated rather a place of study than one for exhibition of objects.

From the fourth to the seventeenth century A.D., according to Goode, the term museum dropped out of use and the idea for which it stood must also have been dormant, yet even in those times many monasteries had collections of curiosities. In the

treasuries of churches also were often preserved curiosities and rarities brought home by pilgrims or travelers. "In some churches," we are told, "eggs of ostriches and other things of like kind, which cause admiration and which are rarely seen, are accustomed to be suspended, that by their means the people may be drawn to church and have their minds the more affected." A few such objects may still be seen in churches. Thus, according to Murray, in the porch of the Cathedral of Merseburg, on the Saale, there is a large carapace of a tortoise. There are "antediluvian" bones in the church of St. Kilian at Heilbronn, and in the old Romanesque church of Alpirsbach, in the Black Forest. One hangs in the western entrance of the Cathedral of Halberstadt, and used to be passed off as one of the bones of Jonah's whale; while on the wall opposite hangs what was called a thunderbolt—or what we would now call a stone axe—kept as a protection against drought and lightning. In the choir of the parish church at Ensisheim, in Upper Alsace, there is a portion of a meteorite which fell in 1492. In the parish church of Petty, on the Moray Frith, the bones of a giant known as "Little John" were preserved in the sixteenth century. Giants' bones were also preserved in the Cathedral of Vienna. Boccaccio records that, in his day, in the Church of the Annunciation in Trapani, in Sicily, three teeth weighing a hundred ounces, of an enormous giant of 200 cubits in height, were hung up on a wire. From such preservations as these it was but a step to collections made by travelers and maintained for their own interest and the gradual accumulation of natural objects under the roofs of colleges and universities. Of such collections there were several of which we have record in the seventeenth century.

Certain natural objects seemed at this time to be especially desired. These were (1) the horn of a unicorn, a fabulous animal which some one was always just on the point of seeing, but never did; (2) Egyptian mummies, whole, if possible, but if not in part; (3) bones of giants, now known to be fossil elephants' bones but then regarded as human; (4) human skulls, especially those of criminals; (5) horns of deer or elk; (6) objects known as *ceraunicæ,* then thought to be thunderbolts but now known to be stone axes; (7) objects called *glossopetræ,* then regarded as serpents' tongues, now known to be arrow heads or fossil shark's teeth. Nearly all of these objects were believed to have great medicinal virtue and, moreover, by the mystery of their origin, appealed to the belief in the miraculous which characterized the time.

A traveler's description of the contents of the Museum of Ludovico Settala, a physician of Milan, Italy, gives an idea of how many such museums were filled in the seventeenth century. "Here we observ'd," he says, "several sorts of very ingenious machines contriv'd for finding out the Perpetual Motion, looking glasses of all sorts, dials, musical instruments, books, medals, curious keys and locks, fruits, stones, minerals, animals; a prodigious variety of shells; and a great piece of cloth made of asbestos." The collection of the University of Leyden, according to a catalogue published in 1691, contained among other things "a Norway house, built of beams without mortar or stone; shoes and sandals from Russia, Siam and Egypt; Chinese songs, paper, books; Egyptian mummies and idols; an hand of a Meermaide; a mushroom above 100 years old; a thunderbolt and a 'mallet or hammer' which the label said 'the savages in New York still kill with.' "

In the arrangement of these museums decorative effects were sought after rather

than any scientific order. The arrangement of the Wormian museum, which was one of the most celebrated museums of the seventeenth century, probably typifies that of many. "On the floor and on two shelves above it," we are told, "were boxes and trays containing small objects, beginning with earths and salts and proceeding in order through the mineral, vegetable and animal kingdoms, till they ended with parts of animals. Interspersed amongst these there was a miscellaneous assemblage of statuary, antiquities, birds, fish, bones, corals and petrifactions. The upper part of the wall was covered with tortoises, crocodiles, lizards, skeletons, spears, lances, arrows, paddles and costumes from Greenland. Between the windows hung horns, antlers and heads of deer and other animals; underneath on the floor lay vertebræ of a whale. From the roof were suspended a great polar bear, a shark and other fish, various birds and an Esquimaux kayak." The anatomical collection at Dresden is said to have been arranged like a pleasure garden, skeletons being interwoven with branches of trees in the form of hedges so as to form vistas. In the anatomical museum of Frederick Ruysch at Amsterdam, plants disposed in nosegays, and shells arranged in figures, were mixed with skeletons of animals and anatomical preparations. The so-called decoration of a cabinet or museum was also deemed of much importance in these times. The tops of the presses or cases, we are told, were frequently ornamented with shells of great size, wasp nests, rhinoceros horns, an elephant's trunk, the horn of a unicorn, urns and busts of alabaster, jasper, marble, porphyry, or serpentine. Here likewise were placed figures of antique bronze, large lithophytes, animals made of shell, gourds cut in two; little trunks of bark, books made of the palm tree, globes, spheres, etc. Even of the British Museum as late as 1786 a visitor said that "it contains many collections in natural history; but, with the exception of some fish in a small apartment, which are begun to be classed, nothing is in order, everything is out of place; and this assemblage appears rather an immense magazine in which things have been thrown at random than a scientific collection destined to instruct and honor a nation." Amid such chaos it is little to be wondered at that the great naturalists of the time, such as Linnæus, Cuvier and Buffon, set themselves above all things to the task of bringing about order, so that system and systematists ruled the eighteenth and nineteenth centuries till their dominance became in turn so great that a revolt appeared which we have witnessed in our own time. The chaotic condition of these centuries was in part the result of the times. The discovery of the new world had brought a flood of new material to the old, and inquiry and interest were active on every hand. The acquisition of new material was deemed more important than the study of that already possessed. Moreover, it was still the age of wonder, and the exceptional things were sought after instead of the common things. The wonder excited by an object of course depends largely upon the interpretation given it, so that many things which seem common and ordinary enough to us to-day were at that time deemed of great interest. Again the museums had in but few cases attained to the dignity of public support, so that those who were in charge of them had to depend upon fees for most of their maintenance. This led to a tendency to procure and exhibit material possessing some morbid or vulgar interest in order that greater attendance might be secured and larger remuneration thus obtained.

Murray says:

While an enormous quantity of material was collected in these museums it was only gradually that its real value began to be appreciated, and that it was turned to proper account. The early museums often had certain definite aims, and were intended to be exponents of science; but natural history was hampered by traditional opinions, and physical science was over-weighted by metaphysics. Everything was explained, but the explanations had always to be in accord with accepted doctrines of logic and metaphysics, which had themselves in turn to square with theology. The wonders of nature had an extraordinary fascination for men of science, who were constantly on the lookout for them. Any variation of the ordinary type of the common object was eagerly sought after, and the more extraordinary it was the greater was its attraction. Hence museums had a tendency to represent the abnormal rather than the normal, what was rare rather than what was common. A museum was a collection of curiosities, and although the word "curiosity" in its older sense had a broader meaning than at present, there was generally implied in it the idea of strangeness or rarity. The object to which it was applied was to be regarded as worthy of being looked at because it was odd or rare.

Among early museums which have survived until our own day the history of the Ashmolean Museum established at Oxford in 1682 may be considered typical. This had its origin in material gathered by John Tradescant and his son earlier in the century. Their collections were extensive and included materials illustrating not only natural history but industrial art and coins. Their collecting seems to have been of an indiscriminate character and without definite classification. These collections were acquired by Elias Ashmole in 1659 and passed by gift to the University of Oxford in 1682. We are told:

On the fifteenth day of May, 1679, the first stone of that stately fabric, afterward called Ashmole's Museum, was laid on the west side of the theater, and being finished by the beginning of March, 1682, there was put therein, on the twentieth day of the same month, about 12 cart loads of rarities sent to Oxon by Mr. Ashmole; which, being fixed in their proper places by Rob. Plot, LL.D., who before had been intrusted with the custody of the said museum, were first of all publicly viewed on the twenty-first of May following by his royal highness James, Duke of York, his royal consort Josepha Maria, Princess Anne and their attendants, and on the twenty-fourth of the same month by the doctors and masters of the university.

Thus rapidity of installation and difficulty of access seem to have characterized this museum. While the museum was evidently invested with a certain amount of importance, it could hardly have been highly appreciated at the time. Edward Young called it "Ashmole's baby house," and the curator, though a man of much learning, received no salary.

Some have urged that because they were derived from single collections, the early museums were, as a rule, confined to special lines, and that museums of broader scope were a product of later development. But so far as I can judge from accounts, the early museums were usually miscellaneous in their character, and development along narrower lines has been a modern practise. Such certainly was the history of the British Museum. This originated largely from two collections, one that of Robert Hubert, who had a collection "of many natural rarities" which he had gathered, according to the account, "with great industry, cost, and thirty years' travel in foreign countries." The other, and the collection upon which the British Museum was chiefly based, was that of Sir Hans Sloane (1660–1752/3), a celebrated physician, president of the College of Physicians and of the Royal Society of England. He early commenced to form a museum, and continued to add to it without intermission until the close of his long life. In 1687 he made a voyage to Jamaica, and is said to have been the first man of learning whom the love of science alone led to that, then distant, part of the globe. He brought home with him not fewer than 800

different species of plants, and this was the first large accession to his collection. His museum and library were said to have cost upward of £50,000, and their value, according to his own and other accounts, was to have been £80,000. At his death he bequeathed his whole collection to the British nation on condition that £20,000 should be paid to his family. The terms in which the bequest was couched showed a keen appreciation of the best means of making such a collection of public use. The will read:

> Whereas from my youth I have been a great observer and admirer of the wonderful power, wisdom and contrivance of the Almighty God appearing in the works of his creation, and have gathered together . . . books, both printed and manuscript . . . natural and artificial curiosities, precious stones . . . dried plants, . . . and the like, . . . amounting in the whole to a very great sum of money: Now, desiring very much that these things, tending many ways to the manifestation of the glory of God, . . . the use and improvement of the arts and sciences and benefit of mankind, may remain together and not be separated, and that chiefly in and about the city of London, where they may by the great confluence of people be of most use, I do hereby request that . . . (my) trustees . . . do make their humble application to Parliament . . . to pay . . . £20,000 . . . unto my executors . . . in consideration of the said collection . . . and also to obtain . . . sufficient and effectual powers . . . for the preserving and continuing my said collection, in such manner as they shall think most likely to answer the public benefit by me intended.

Sloane's gift was accepted by the British Parliament, and in 1773 an Act was passed for the purchase of the Sloane library and museum and of the Harley collection of charts and manuscripts, which was in the market at the time, for uniting them with the Cotton Library, and for providing one "general repository" for these and other additions that might thereafter be made. The act authorized the raising of the funds required by means of a lottery, and fully £90,000 was thus obtained. The three collections thus acquired and housed became the British Museum, which opened to the public on Monday, January 15, 1759. As originally organized, the British Museum was divided into three departments: (1) Manuscripts, medals and coins; (2) natural and artificial productions; and (3) printed books. In 1802 the great collection of Egyptian antiquities acquired under the capitulation of Alexandria passed into the museum. This was followed in 1805 by the purchase of the Townley marbles and terracottas, and the bronzes, coins, gems and drawings in 1814. These acquisitions rendered it necessary to create a new department, that of antiquities and art, to which were united the prints and drawings as well as the medals and coins. Botany was added as a fifth department in 1827, after the bequest of Sir Joseph Bank's collection. In 1837 the prints and drawings were separated from the department of antiquity and became an independent department. At the same time the department of natural history was divided into two, one of geology, including paleontology and mineralogy, and the other of zoology. In 1857 mineralogy was constituted a separate department. In 1861 the department of antiquities was subdivided into (1) Greek and Roman antiquities, (2) coins and medals, (3) Egyptian and Assyrian antiquities; and in 1866 the British and medieval antiquities were formed into a separate department along with the ethnographical collections. Between 1880 and 1883 the natural history collections were transferred to the new Natural History Museum in Cromwell Road.

In our own country the earliest general collection of natural history objects formed is said by Goode to have been one made at Norwalk, Conn., by a Mr. Arnold. This was prior to the Revolution. It was described as "a curious collection of American

birds and insects." This collection served at least one important purpose, since it is said to have awakened in President John Adams an interest in natural science which led to the founding of the American Academy of Arts and Sciences.

The first natural history museum to be established in our country, so far as appears from present records, was at Charleston, S. C., in March, 1773. This was founded under the auspices of the Charleston Library Society. The society urged, in order to present a "full and accurate Natural History" of the Province, that all the "natural Productions, either Animal, Vegetable or Mineral that can be had in their several Bounds," be sent to them. It is gratifying that this museum has retained its existence to the present day and under the influence of its present able and energetic director is younger and stronger than ever. As might be expected, Massachusetts did not yield long in initiative to South Carolina, so that we find the next natural history museum to be established in this country was at Salem, Mass., in 1799. This was founded to provide a permanent home for the collection of the East Indian Marine Society. Salem was at that time a great trading port and its ships traveled over all the world. Returning ship-masters brought back the products of many lands, and these rapidly formed an important collection. We are glad to record for this institution also a continuous career and abounding vitality at the present time. Another important early natural history museum in this country was the private museum of Charles Wilson Peale. Peale was a portrait painter of Philadelphia, but, though an artist by profession, was much interested in natural history. The foundation of his collection was a few of the bones of a mammoth, which he acquired in 1785. Sixteen years later he obtained the first entire skeleton of this animal which had, up to that date, been found. Besides specimens of natural history his museum contained wax figures of the different nations of the North American Indians, a collection of their arms and utensils, other Indian and European curiosities, and casts of ancient gems and statues.

The United States National Museum was practically founded in 1846, when, under the plans for using the Smithson bequest, arrangements were made for a museum in what is, incidentally, one of the longest sentences on record, as follows:

> Whenever suitable arrangements can be made from time to time for their reception, all objects of art and of foreign and curious research, and all objects of natural history, plants and geological and mineralogical specimens belonging to the United States, which may be in the city of Washington, in whosesoever custody they may be, shall be delivered to such persons as may be authorized by the board of regents to receive them, and shall be so arranged and classified in the building erected for the Institution as best to facilitate the examination and study of them; and whenever new specimens in natural history, geology or mineralogy are obtained for the museum of the Institution, by exchange of duplicate specimens which the regents may in their discretion make, or by donation which they may receive, or otherwise, the regents shall cause such new specimens to be appropriately classed and arranged.

In pursuance of this plan, in the building erected for the Smithsonian Institution, 30,000 square feet of space was made available for exhibition purposes. Occupancy of this was acquired in 1858. This space became inadequate after the Centennial Exposition, and in 1881 a new building providing 90,000 square feet of space was added. This building was occupied in part by industrial and historical collections, but those of natural history required by far the largest space. In a little more than twenty-five years the natural history collections, in which is included anthropology, had so in-

creased in importance and extent that a new building having 233,000 square feet of exhibition space and 160,000 square feet of laboratory and storage space was provided for these collections alone. The earlier buildings had no provision for laboratory or storage space. Another indication of the expansion of the National Museum in natural history lines is afforded by the fact that whereas as late as 1893 there was but a single curator or custodian of insects, at the present time there are nine.

In addition to changes in space the National Museum underwent changes from the administrative point of view which have been described by Goode as follows. There were three periods, he says:

First, the period from the foundation of the Smithsonian Institution to 1857, during which time specimens were collected solely to serve as materials for research. No special effort was made to exhibit them to the public or to utilize them except as a foundation for scientific description or theory.

Second, the period from 1857, when the institution assumed the custody of the "National Cabinet of Curiosities," to 1876. During this period the museum became a place of deposit for scientific collections which had already been studied, and these collections so far as convenient were exhibited to the public and, so far as practicable, made to serve an educational purpose.

Third, the period beginning with the year 1876, in which the museum undertook more fully the additional task of getting collections and exhibited them on account of their value from an educational standpoint.

The progress that has here taken place in the active acquisition of specimens instead of the passive reception of them and in paying more attention to exhibition of material, may be said to have characterized all active natural history museums in this country in the past half century.

The colleges of the country were in earlier periods, as now, centers to which natural history materials normally flowed, such materials being both acquired for teaching purposes and deposited for safe keeping. But the attention and funds devoted to the display and preservation of these objects were in most cases, meager, and little effective effort towards the establishment of a natural history museum in connection with a college or university in this country seems to have been made until that initiated by Professor Louis Agassiz at Charleston in 1850 and at Harvard College in 1852. Agassiz's stay at Charleston was too brief to effect noteworthy results, but at Cambridge he accomplished much. He found little material there suitable for illustrating his lectures upon geology and zoology and with characteristic zeal and energy he set about supplying the deficiency. Indeed it is possible that he regarded the founding of a museum as his most important work, since he expressed his purpose to "consecrate all his energy and ability to the creation of a great museum, the best arranged and most perfect in the world." It is a great tribute to the ability and enthusiasm of Agassiz that he was able under the shadow of the impending civil war to raise the sum of nearly $200,000 from the legislature and citizens of Massachusetts for the founding of this museum. Agassiz stated his purposes in establishing the museum to be: "(1) To express in material forms the present state of our knowledge of the animal kingdom; (2) To make the museum a center of original research, where men who are engaged in studying the problems connected with natural history could find all they needed for comparative investigation; and (3) To make the museum an educational institution having a widespread influence upon the study, the love and the knowledge of nature through-

out the country." That this museum has fulfilled and is fulfilling these high purposes no one will gainsay. Not only has it been a model institution in itself, but men trained in it have been active in the upbuilding of other museums.

Whether stimulated chiefly by the influence of Agassiz or by that of the Salem Museum, or if either, I do not know, but in 1867 the cause of college natural history museums was further advanced by the gift by George Peabody of $150,000 to Harvard College for a museum of archeology and ethnology, and of the same amount to Yale for a general natural history museum. Both of these funds have served to maintain important and valuable museums. A large and attractive natural history museum has recently been established at Princeton University, and many other universities and colleges in this country now have such museums of size and importance, some institutions of lesser means being better equipped in this regard than those with larger funds.

The formation of natural history collections in connection with the work of learned societies has often occurred and has led to the founding of several important museums in this country. Examples are the Museum of the Philadelphia Academy of Sciences, founded in 1812, and that of the Boston Society of Natural History, founded in 1830. Such institutions have performed services of incalculable value by their preservation of specimens and stimulation of continued interest in natural history.

With the exception of the aid given to the Charleston Museum by the city of Charleston in 1850 the first establishment of a museum of natural history under municipal auspices in this country seems to have been that in New York City in 1869. Leading citizens there, realizing the importance in the cultural growth of the city of such an institution, procured a charter from the legislature and obtained funds by private subscription. At first the city was asked to erect a single building to shelter both the museum of natural history and the museum of art, but fortunately sites were granted for a building for each. Fortunately also the plan of the building designed for the natural history museum was on a scale sufficiently large to provide for future growth. The first unit of the contemplated building was opened in 1877, and in less than forty years a large part of the original plan has been carried out, the present magnificent structure has been erected and it has been filled with precious material. In the view of the Hon. Joseph H. Choate, "the money spent by the City of New York in the development of this Museum and the Museum of Art is the best investment of public moneys ever made by it, whether we consider the direct benefit to the people or the prestige and character attained by the city as the great metropolitan center of knowledge and culture."

While the example set by New York City of supporting a great natural history museum largely by public funds has not been followed in exact form by many other American cities, the principle has been accepted either by the donation of sites and other privileges to museums founded by private munificence, or by municipal assistance to museums inaugurated by learned societies. The city of Milwaukee supports its natural history museum by a municipal tax, and there are gratifying indications that other cities will sooner or later adopt this method of support of museums. All cities should recognize such museums as an essential feature of their cultural equipment. Oakland, Denver, Providence, Charleston and Grand Rapids may be mentioned as cities which have already shown sufficient appreciation of such institutions to found or support

them. Among institutions supported by public funds several state museums which are doing work of great importance should also be mentioned.

To the beneficence of single donors has been largely due the founding of such museums as the Peabody, Field and Carnegie Museums. Such gifts as well as those of private individuals to museums already established show an interest on the part of individuals which has been in advance of that of the general public.

The natural history museums of Canada have developed chiefly under governmental or university auspices, and we are glad to note that increased appreciation and support seem to be accorded them in recent years.

The National Museum of Mexico has an excellent natural history section in which important material is preserved. Most South American countries maintain natural history museums, especially in their capitals, those of Brazil, Argentina and Chile being especially worthy of mention.

An endeavor to establish natural history museums and collections especially adapted to the interests of children has marked a new line of progress in recent years. The results have been very gratifying and promise wide usefulness. The purpose of such museums was well stated when in the plan of the Children's Museum of Brooklyn it was said that its purposes were "to form an attractive resort for children with influences tending to refine their tastes and elevate their interests; to create an attractive educational center of daily assistance to pupils and teachers in connection with school work; and to offer new subjects of thought for pursuit in leisure hours." Through a somewhat similar movement there has been brought about in many localities close connection between natural history museums and school work. This movement also seems destined to greatly increase the usefulness of natural history museums since it widens their appeal and brings about an acquaintance of the child with the museum which is likely to be an abiding and elevating influence.

The wide-spread public interest and support accorded to natural history museums which we have noted as occurring in recent years seem to mark a new era in their history. In earlier years these museums, partly perhaps because of the auspices under which they were founded, addressed their appeal chiefly to the learned and the specialist. They either did not endeavor to develop or did not succeed in developing wide public interest. Such an attitude was unfavorable both to the museums themselves and to the public. It tended to make the museums mere storehouses for the accumulation of material, and it gave the public an unfavorable opinion of their possibilities. Much of the awakening which I have noted as having taken place has no doubt had its origin in the labors of museum workers themselves, since they, with marked originality and enthusiasm, have shown what possibilities in the way of education and recreation lay in museums and their contents. Sir Hans Sloane's principle of the desirability of establishing museums where there is a "great confluence of people" seems also a sound one, since it is in such museums that the most marked development has taken place in the past quarter century. This does not mean that splendid work is not being done by museums in smaller communities, but simply that, since larger communities have as a rule larger opportunities, they may obtain greater results when they improve these opportunities.

Next to what may be called the democratization of natural history museums perhaps the most significant feature of their development in the last quarter century

may be said to be the introduction of art into their methods of illustration and exhibition. Not only has a pleasing variety thus been gained in the old methods of installation, but the attractive and well modeled groups which have been made effectively supplement the long rows of birds, shells, rocks, etc., which constituted the sole exhibits of earlier museums. In modern practise there are thus shown with more or less detail not only objects, but their environment and surroundings. The lesson taught by a single object no longer suffices; it must be represented, if possible, in its natural setting. This is, consciously or unconsciously, a recognition of the fact that nothing in nature is of isolated origin; it is the product of the working of complex and varied forces. These forces, then, should be at least hinted at in the representation of the object. The food of an organism, the various stages of its development, its habitat and its habits must be represented before the organism itself can be thoroughly understood. But in the development of this attractive and fascinating field, one note of caution should perhaps be sounded. A tendency to prefer imitation to reality is not one which those interested in the progress of science at least should seek to promote. The existence of this tendency from early times is shown us in the incident of the Greek audience who applauded wildly the actor who imitated the squealing of a pig, but drove off as an impostor the peasant who produced real squeals from a pig hidden under his coat. A chance companion with whom I visited the battlefield of Gettysburg was continually referring with enthusiasm to the well-known panorama of that battlefield, while in the locality itself he took not the slightest interest. Desirable as is the introduction of the best of art into our natural history museums, it should not usurp the place of science, for otherwise they become museums of art and not of science. Highly desirable as are museums of art and much as observance of the principles of art is needed in the conduct of natural history museums, we should not confuse them in modern development.

Another cause for recent increased interest in natural history museums is doubtless a growing appreciation of the value of nature study. The exigencies of city life have practically closed the book of nature to many dwellers in cities. There is one school district that I know of in Chicago which contains only two trees and at last accounts one of them was dying. How shall the wonderful lessons of nature of which man is after all but a part, be taught to children in the city unless there be institutions which will depict and reproduce its forms? If city life means that thousands of children can never see birds, butterflies, flowers, rocks, etc., in their native haunts, the city should try to provide means to show the form and, wherever possible, the substance of these things, especially as in doing so it can provide a far larger variety than would naturally occur in any single locality.

Another reason for an increased interest in the work of natural history museums may arise from a realization of how rapidly many of the forms of nature are vanishing before the progress of man and his works. The leveling of forests, draining of marshes and irrigating of deserts cause marked changes in nature. The destruction of one species makes changes in the habits and habitat of others. These in turn react upon their environment and cause new confusion. The practical disappearance of the Indian from the North American continent was not wholly due to his forcible segregation by the white man, but in part at least to the destruction of the buffalo, which constituted his normal food supply. With the buffalo disappeared, in part, at least, the

wolves and eagles which fed upon them. These in turn are doomed to practical extinction. A large share of the animals and plants inhabiting this continent at the time of its discovery by Europeans are not destined to survive long except as they are protected by man, and some will become extinct in spite of him. The wild pigeon, so common in Audubon's time that he saw shiploads which had been caught up the Hudson for sale on the wharves of New York for a cent apiece, has become entirely extinct. Other birds, flowers and even minerals have also become extinct in this country since the first coming of the Europeans. To museums must be largely assigned the work of conserving the remains of such forms ere they are absolutely lost. Specimens which are valuable now will be priceless in years to come. As but a single illustration of the value which specimens preserved now may prove to have later, may be mentioned the fact that an important link in the study of mutations has lately been furnished by specimens collected in this country by Michaux in 1785 and preserved in the Natural History Museum of Paris.

Again, interest in natural history museums has doubtless been quickened in recent years through recognition of the evolutionary trend of nature. This has given new meaning to her works and suggested interesting methods for the arrangement of collections. Where so well as in museums can the successive stages be shown by which the progress of nature has gone on, by which the creature has become adapted to its environment and the fittest has survived? As this great law of life is found more and more to express nature's methods, its lessons can be convincingly and satisfactorily taught by museums.

While a desire for more knowledge of nature has been the prevailing influence in the establishment of natural history museums, it should not be forgotten that these museums have themselves in turn contributed much to a knowledge of nature. Not only has this been done by research work and publications, but even in some cases by the mere necessity for orderly arrangement of museum material. The science of archeology is said to have dated its origin from the time of the arrangement of the Museum of Copenhagen. The study of meteorites has been made possible as a science by the accumulation of a large number of these bodies by museums. All biological sciences must admit their obligations to natural history museums for many of the data which have aided in their development.

The brief sketch which has been submitted serves to show that natural history museums must now be fully recognized as an indispensable feature of modern civilization, and I believe that the progress of civilization will only fix them more firmly in this place. The vicissitudes which the development of these museums has suffered have only emphasized their importance and made more evident their functions. The opportunities which now open before them are larger and at the same time more clearly defined than ever.

As an ideal toward which not only natural history museums, but all museums, so far as the outlook at the present day is concerned, should work, I can not do better than to quote, with some slight modifications, an utterance of Ruskin:

> The first function of a museum is to give an example of perfect order and elegance. Everything should be in its own place, everything looking its best because it is *there*. Nothing should be crowded, nothing unnecessary. The museum is only for what is eternally right and well done. The least things are there and the greatest, and all good. The simple may go there to learn, and the wise to remember.

Oliver Cummings Farrington
Field Museum of Natural History

THE BACTERIA OF THE INTESTINAL TRACT OF MAN[1]

It has been stated that the average healthy adult on a normal mixed diet excretes daily in the feces a number of bacteria, which have been variously estimated from 128 billion to 33 trillion. This truly enormous number of bacteria would weigh approximately 5.5 grams when dried, and the nitrogen in this dried mass would be about 0.6 gram, corresponding to from 46 to 50 per cent. of the total fecal nitrogen. It is very certain that this number of bacteria is not taken in the food, and, furthermore, the fecal organisms are not necessarily the same as those found in the food. Hence the conclusion is reached that there must be a very great daily proliferation of bacteria in the intestinal tract, and in this sense the intestinal tract is the most efficient and active combined culture medium and incubator with which science is familiar.

The question naturally presents itself, why is there such a tremendous growth of bacteria daily, and why is it that the bacteria taken in with the food are not those which appear in the fecal contents? A rapid survey of the life history of the intestinal bacteria will explain at least some of the facts. At birth the intestinal content, the meconium, is sterile. This would be expected, because the uterine cavity is sterile. Very shortly after birth bacteria make their appearance in the mouth of the new-born, and organisms appear in the meconium from four to twenty hours post partum, depending upon environmental conditions. This initial infection of the meconium is a mixed one. Various adventitious organisms, even pathogenic bacteria, may appear in it. This is a period of mixed infection, and the number of organisms in the meconium increases rapidly after the first food enters the intestinal tract. After two to three days post partum, when the intestinal tract has become thoroughly permeated with milk, the organisms observed in the feces—for the meconium has largely disappeared by this time—begin to assume a monotony of form and a regularity of type, which contrasts sharply with the preceding period of mixed infection. This is a transitional period during which the permanent characteristic nursling bacteria appear and soon become dominant.

The types of bacteria which constitute the normal fecal flora of the nursling are few in number and definite in their chemical characters. The most prominent of these, *B. bifidus,* so-called because of its developmental peculiarities in artificial media, is a strict anaerobe. Other organisms, the so-called Kopfchen bacillus, *B. coli, B. lactis aerogenes* and *Micrococcus ovalis,* are, as a rule, very much fewer in numbers than *B. bifidus,* and, under normal conditions, apparently less important. The question arises, why should an obligate anaerobe, as *B. bifidus,* dominate the nursling's intestinal flora? It must be remembered that breast milk, which is the normal diet of the nursling, consists monotonously of about 7 per cent. of lactose, about 3 per cent. of fat, and but 1.5 per cent. of protein. Consequently, the intestinal tract of the infant under ordinary conditions is practically continuously bathed in a nutrient medium containing at all times at least a minimal amount of sugar. The normal infantile feces is always slightly acid in reaction, and this acid is lactic acid chiefly. It is a significant fact that the dominating organism, *B. bifidus,* is a lactic acid-producing microbe. It is also a significant fact that the reaction of the normal nursling feces is acid enough to inhibit the growth of practically all putrefactive bacteria; there are few or no putrefactive bac-

[1] From the Bacteriological Laboratory of the Northwestern University Medical School.

teria in the normal infantile feces. There appears to be a definite relationship between the high percentage of lactose, the dominance of an obligately lactic acid-fermenting organism, and the absence of putrefactive bacteria in the normal infantile intestinal flora. This infantile flora, furthermore, appears to be a protective one in the sense that it inhibits the growth of bacteria which might produce either putrefaction or disease. These latter organisms are somewhat intolerant of lactic acid. It may be remarked parenthetically that one of the first indications of intestinal disturbance in infants is the temporary or even permanent disappearance of this lactic-acid flora.

B. bifidus is an organism which does not thrive in artificial media in the absence of sugars, and it is not surprising to find, therefore, that as the breast-fed infant becomes older and its dietary demands more varied, *B. bifidus* tends to disappear from the fecal mass. In the case of bottle-fed babies, this disappearance practically coincides with the substitution of cow's milk for human milk. Cow's milk contains relatively less sugar and more protein than human milk. In either instance, the decrease of *B. bifidus* appears to follow very closely, under normal conditions, the change in diet which results in a diminished amount of carbohydrate in proportion to the nitrogenous substance. That is to say, as the proportion of protein increases and the proportion of carbohydrate decreases in the diet, *B. bifidus* also tends to decrease. The decrease in the typical nursling organisms is accompanied by an increase in the numbers of *B. coli* which then dominate the intestinal tract and form about 80 per cent., roughly, of the total living fecal organisms of adolescence, and which persist in this proportion in normal individuals until death.

B. coli differs from *B. bifidus* in one noteworthy respect. *B. bifidus*, as has been pointed out before, is a strictly, almost obligately, fermentative organism: it does not grow in the absence of sugars. *B. coli* is far more plastic in this respect: it can grow equally well in media containing protein and utilizable carbohydrate, or in media from which utilizable carbohydrates are excluded. It can accommodate its metabolism to the varying foods presented to it in the intestinal contents. This plasticity of the colon bacillus and its ability to develop in the average intestinal contents, explains in a satisfactory manner the dominance of this organism throughout life.

Turning now to the distribution of bacteria in the intestinal tract of the normal adults, it is found that the stomach contents are practically sterile under normal conditions. The usual explanation for this sterility is the acidity of the gastric contents, and while this explanation may not be wholly satisfactory, it suffices for the moment. When the hydrochloric acid acidity of the stomach contents becomes diminished through disease, it is found that the numbers of bacteria in the stomach contents may increase greatly. The duodenum also during those periods when it is empty is practically sterile. The bacterial population increases as duodenal digestion increases, and diminishes as the duodenal contents are passed on to the lower levels.

The greatest number of bacteria, living bacteria, that is, is found in the region of the ileocecal valve and the ascending branch of the colon. Here the contents stagnate, as it were, and they eventually become so desiccated through the withdrawal of water that bacterial life is retarded. From the ascending colon progressively to the end of the intestinal tract the number of living bacteria under ordi-

nary conditions appears to diminish, although there are even in the fecal contents great numbers of living organisms.

The significance of the intestinal flora has been variously interpreted. Various theories have been proposed to explain their relation to the well-being of man. The theory which has received the greatest attention is that one which assumes that the normal intestinal bacteria assist the digestion of food for the host through the elaboration of certain ferments, and also that these organisms are under normal conditions in a sense a protection to the host in that their activities are in opposition to those of adventitious pathogenic bacteria, which might otherwise gain a foothold in the intestinal tract and become invasive. A certain amount of theoretical evidence was originally brought forth in support of the digestive action of the intestinal bacteria: it was assumed that in the herbivora certain cellulose-dissolving bacteria were very active and that the activities of these bacteria made assimilable the otherwise resistant cellulose.

Certain observers have attempted to approach the problem of the significance of the intestinal bacteria from another point of view. Nuttall and Thierfelder delivered guinea-pigs by Cæsarean section and attempted to raise them in a sterile environment on sterile food. For two weeks these sterile guinea-pigs increased in weight and appeared to be reasonably healthy. These observers drew the conclusion that the intestinal bacteria were not necessary for the well-being of these guinea-pigs at least. These experiments were not accepted by Schottelius as being conclusive. He claimed that the experiments were not carried on long enough. Schottelius experimented with chicks hatched from sterile eggs. Parenthetically, it should be remarked that Schottelius had the greatest difficulty in finding sterile eggs to start with. However, after considerable investigation he succeeded in getting a considerable number of sterile eggs which he divided into three groups. These were incubated under sterile conditions, and the chicks developing from one group were kept in an absolutely sterile environment and fed on sterile food; a second group were kept under the same conditions for ten days and then fed with infected food; the third group were controls and were kept under ordinary conditions. The first group, the sterile chicks, did well for ten days, but after that time their development was seriously retarded. The second group also did well for ten days, and then, as the first group began to exhibit signs of abnormalities, they were placed on infected food: they gained rapidly. The third group, kept under ordinary conditions, did well from the start. Schottelius believed that his experiments showed that the intestinal bacteria were necessary for the development and well-being of chicks.

Madame Metschnikoff made similar observations on tadpoles, and Moro performed the same experiments with turtles. These observers agree with Schottelius that the intestinal flora appear to be necessary for the well-being of the animals they experimented on.

A line of evidence which is somewhat different from this was brought forward by Levin. He examined the fecal contents of many Arctic mammals in the Arctic regions, and he found few or no bacteria in them. He believed that an intestinal flora was unnecessary for the development of these animals. It should be remarked parenthetically, however, that Arctic mammals brought to the temperate regions rapidly acquire an intestinal bacterial flora, and these organisms do not seem to interfere with the well-being of their host.

The net result of these experiments would suggest that man has a bacterial population in his intestinal tract; that under normal conditions the organisms in the intestinal tract are fairly characteristic and constant; normally they are harmless; they may be protective; and that up to the present time it is practically impossible to get rid of them.

Attempts have been made to sterilize the intestinal contents, either by administering sterile food or by the use of antiseptics. Sterile food appears to reduce somewhat the numbers of intestinal bacteria, but the reduction is not great, and this line of experimentation has not been successful. Many different kinds of antiseptics have also been tried, and while various results have been claimed, the net result appears to be that the temporary reduction in numbers, which is frequently observed, is largely referable to increased peristalsis and quick removal of the intestinal contents. It has become apparent from these observations that the strength of antiseptics necessary to sterilize the intestinal contents would be sufficient to kill the host long before the bacteria were eliminated.

The intestinal bacteria may become a menace to the health of the host. Occasionally, adventitious bacteria, as the typhoid, dysentery, cholera, or paratyphoid organisms, much less commonly the tubercle bacillus, may gain lodgment in the intestinal tract, increase greatly in numbers, invade the tissues of the host, and, if care is not taken to sterilize the feces, produce progressive disease from host and host. From the individual point of view the intestinal flora under ordinary conditions are innocuous, and perhaps even to a moderate degree protective. Under abnormal conditions, when progressively pathogenic bacteria gain a foothold in the intestinal tract, the intestinal flora may become a menace to health and even to life. The significance of the intestinal contents to man in general is perfectly obvious. The tremendous numbers of bacteria which can be excreted daily, particularly if they happen to be disease-producing, as typhoid, may become a matter of real concern to the health of communities, for the disposal of feces in a manner to render them innocuous is not a particularly simple matter. Once the intestinal bacteria have escaped into water supplies, or have gained access to foods, the progressive damage which may be brought about may be very great.

A. I. KENDALL
NORTHWESTERN UNIVERSITY

PROTECTION OF BIRDS IN THE MALAY PENINSULA

DR. WILLIAM T. HORNADAY, director of the New York Zoological Park, has received the following letter, written on July 12, from the officers of the Dutch committee on the protection of birds, of which Dr. C. Kerbert, director of the Amsterdam Zoological Gardens, is chairman:

We are pleased to be able to inform you that the committee for the advancement of a prohibition of the export of birds and parts of birds from the Dutch Colonies has received from the corresponding member of the committee, Dr. J. C. Königsberger, director of "'s Lands Plantentuin" at Buitenzorg, Java, the following information about the shooting of birds of paradise:

1. This year (and probably also in future) the shooting is limited to these species: *Paradisea minor, Seleucides nigricans* and *Ptilornis magnificus.* The export of skins of all other species is prohibited by the Dutch Colonial Government, and these skins have therefore no commercial value.

2. Shooting is *totally* prohibited in the islands of the "Radja Ampat" group (Misole, Salawatti, Batanta and Waigou), and in those of the Geelvink Bay in New Guinea, as well as in two large reservations on New Guinea, on both sides of the Geelvink Bay.

By these means the protection of the rarer birds of paradise is obtained, and we have every hope that in future the shooting of all birds of paradise will be totally stopped.

The three species not yet protected are the lesser birds of paradise, the twelve-wired bird of paradise and the rifle-bird. Inasmuch as bird protection continually gains in public favor, it is safe to predict that within a reasonable time all the birds of the Dutch East Indies will receive the complete protection that an embargo on exportations easily can afford. In this connection it is to be noted that on January 1, 1915, a law prohibiting the importation of wild bird's plumage for commercial purposes went into effect over the whole dominion of Canada, and thus the prohibition now covers North America north of Mexico.

REVERCHON PARK, DALLAS, TEXAS

AT a recent meeting of the park board of Dallas, a tract of land of 36 acres recently purchased and provisionally named "Turtle Creek Park" was formally named "Reverchon Park" in honor of the botanical work of Mr. Julien Reverchon.

Julien Reverchon was born near Lyons, France, in 1837. When eighteen years of age he came with his father to America and settled in the French colony near Dallas. In France when fourteen years of age he had a collection of 2,000 species of plants. Throughout fifty years at Dallas up to his death in 1905 he continued active work in the collection and study of plants. The estimate of his worth and work is perhaps best given in the words of botanists who knew him well, as here indicated.

Dr. E. G. Eberle, intimately associated with him, here states:

It was largely due to his efforts that the Texas flora became known. He freely contributed botanical specimens to various institutions of science and learning, to the agricultural department of the United States and to the Smithsonian Institution. His collection included plants not only of Texas but of all parts of North America and foreign countries, totaling more than 10,000 specimens representing more than 3,000 species.

This collection was secured for the Missouri Botanical Garden in 1906.

Dr. Asa Gray many years ago in naming the genus *Reverchonia* referred to him as "a valuable correspondent, an acute and sedulous botanist."

Dr. Wm. Trelease, University of Illinois:

I, indeed, think that Dallas should commemorate in one of its parks the name of Julien Reverchon, a man of rare intelligence and enthusiasm whose work on the native plants of Texas and particularly of Dallas County, will long stand as of the fullest and best.

Dr. J. M. Greenman, Missouri Botanical Garden, St. Louis:

The scientific value of Mr. Reverchon's botanical work is sufficient to insure his name a permanent place in the literature of the botany of Texas and the great southwest. Duplicates of his collections occur in many of the leading herbaria of the world.

Dr. Wm. L. Bray, Syracuse University (formerly professor of botany, State University of Texas):

. . . In the case of Reverchon, however, this naturalist instinct was, perhaps, of a more cosmopolitan character. He and his two brothers had been collectors over very wide areas. He was in a position to give discerning judgments as to plants and plant conditions in a territory toward which the eyes of people in both America and Europe were turned. A precursor of our modern ecological plant geographer, his was a notable life which had relation to the unworked field, on the one hand, and the working botanical centers, on the other. We have few such intermediaries nowadays, unfortunately.

Dr. John M. Coulter, University of Chicago:

I have your letter in reference to naming one of your parks "Reverchon Park."

It seems to me that nothing could be more appropriate, for to the botanists of the country the name of Reverchon has always been identified with our early knowledge of the flora of Texas. It seems to me that it would be regarded by the botanical fraternity in general as a very happy method of remembering a botanist whom Texas should not forget.

Dr. Charles S. Sargent, Arnold Arboretum, Jamaica Plain, Mass.:

No one did more than Reverchon in exploring the flora of Texas. He made it possible for

others to make known the remarkable richness of the Texas flora. His name is well known and highly respected by every one interested in American plants. He was an accomplished botanist and an indefatigable collector and it is proper that this distinguished citizen of Dallas should be honored in the way you suggest.

"Reverchon Park" is a wooded tract along Turtle Creek in the north part of Dallas and is capable of great beautification.

O. C. Charlton

Dallas, Texas,
June 18, 1915

BRITISH SCIENTIFIC MEN IN MILITARY SERVICE

There is published in *Nature* a list of members of the scientific staffs of universities and other institutions of higher education who have enlisted in the British army or navy, including the medical and engineering services. The lists for the Universities of Oxford and Cambridge are as follows:

OXFORD

Adams, P. E. H., reader in ophthalmology, Captain R.A.M.C.

Bazett, H. C., demonstrator in pathology, Lieutenant R.A.M.C.

Bourne, Dr. G. C., Linacre professor of comparative anatomy, Major 12th Worcesters.

Buxton, L. H. D., demonstrator in physical anthropology, 2d Lieutenant.

Collier, W., Litchfield lecturer in medicine, Major R.A.M.C.

Dodds-Parker, A. P., Litchfield lecturer in surgery, lecturer in applied anatomy, Lieutenant-Colonel R.A.M.C.

Douglas, Dr. C. G., demonstrator in physiology, Lieutenant R.A.M.C.

Douglas, J. A., demonstrator in geology, 2d Lieutenant R.A.M.C.

Dreyer, G., professor of pathology, honorary consulting pathologist, 3d Southern General Hospital.

Foster, E. C., assistant demonstrator in human anatomy, Major R.A.M.C.

Gibson, Dr. A. G., lecturer in morbid anatomy, Captain R.A.M.C.

Gill, W. B., demonstrator in physics, Lieutenant R.G.A.

Gunn, J. A., reader in pharmacology, Lieutenant R.A.M.C.

Hasell, E. W., demonstrator in rural economy, Lieutenant.

Jenkin, C. F., professor of engineering science, Lieutenant R.N.V.R. (air service).

Jenkinson, Dr. J. W., lecturer in embryology, Captain (killed in action at Dardanelles, June 4, 1915).

Ogilvie, A. G., demonstrator in geography, Lieutenant Royal Field Artillery.

Osler, Sir W., regius professor of medicine, Hon. Colonel S. Midland Division R.A.M.C.

Smith, G. W., demonstrator in comparative anatomy, Captain.

Tizard, H. T., demonstrator in physics, 2d Lieutenant Royal Garrison Artillery, attached R.F.C.

Townsend, J. S. E., Wykeham professor of physics, Lieutenant R.N.V.R. (air service).

Walker, Dr. E. W. A., lecturer in pathology, honorary consulting pathologist, 3d Southern General Hospital.

CAMBRIDGE

Assheton, Dr. R. T., lecturer in animal embryology, 2d Lieutenant.

Bragg, W. L., lecturer in natural sciences, 2d Lieutenant.

Deighton, F., teacher of vaccination, Lieutenant R.A.M.C.

Dunlop, J. G. M., assistant-lecturer in chemistry, Lieutenant (died August 26, 1914).

Entwistle, F., second observer, the Observatory, Lieutenant.

Fay, C. R., Gilbey lecturer in agriculture, 2d Lieutenant.

Gray, J., demonstrator in comparative anatomy, 2d Lieutenant.

Gregory, R. P., university lecturer in botany, Lieutenant.

Hele, T. Shirley, lecturer in natural sciences, Captain R.A.M.C.

Heycock, C. T., Goldsmiths' reader in metallurgy, Lieutenant-Colonel.

Hill, A. V., Humphrey Owen Jones lecturer in physical chemistry, Captain.

Hindle, E., assistant to Quick professor of biology, Lieutenant R.E. (signalling section).

Hopkinson, B., professor of mechanism and applied mechanics, Major C.U.O.T.C.

Inglis, C. E., lecturer in mechanical engineering, Lieutenant Royal Engineers.

Kempson, F. C., demonstrator of human anatomy, Lieutenant R.A.M.C.

Lees, S., fellow of St. John's, Engineer-Lieutenant R.N.

Littlewood, J. E., lecturer in mathematics, 2d Lieutenant R.G.A. (Wessex).

Lucas, Dr. K., demonstrator in physiology, Army Aircraft Factory.

Marrack, J. R., fellow of St. John's, working at the Research Hospital, Cambridge, Lieutenant R.A.M.C.

Moss, W., junior observer, Solar Physics Observatory, Cadet Cambridge University O.T.C.

Myers, Dr. C. S., lecturer in experimental psychology, Major, R.A.M.C.

Nicholas, T. C., sub-lecturer in geology, Staff-Major Mediterranean Force.

Parker, W. H., sub-lecturer in agriculture, 2d Lieutenant 11th Suffolk.

Peters, R. A., research fellow (physiology), Gonville and Caius, University demonstrator, Lieutenant R.A.M.C.

Potts, F. A., director in natural science, Trinity Hall, 2d Lieutenant 9th West Riding Regiment.

Roberts, H., lecturer in physiology and anatomy, Lieutenant R.A.M.C.

Robertson, D. H., sub-lecturer in economics, 2d Lieutenant 11th London.

Rolston, W. E., junior observer, Solar Physics Observatory, Lieutenant East Kent Regiment.

Stratton, F. J. M., University lecturer in astrophysics, Captain 20th Div. Syn. Co., R.E.

Thirkill, H., demonstrator in experimental physics, 2d Lieutenant R.E.

Thomas, H. H., curator of botanical museum, 2d Lieutenant Chesh. Brigade R.F.A.

Wilson, G. H. A., lecturer in mathematics, Captain (Army).

Woodhead, G. Sims, professor of pathology, Lieutenant-Colonel R.A.M.C.

Wright, C. S., lecturer in surveying and cartography, 2d Lieutenant Royal Engineers.

THE AMERICAN CHEMICAL SOCIETY

THE fifty-first meeting of the American Chemical Society will be held in Seattle, Wash., Tuesday, August 31, to Friday, September 3, inclusive. A special train will leave Chicago at 5.05 P.M. August 26, over the Northwestern Railroad. One and one-half days will be spent at Glacier National Park; one day at Mt. Ranier National Park; one day as the guests of the Oregon Section at Portland, Ore., including luncheon and an excursion on the Columbia River. The members will disband following a smoker to be given by the California Section of the society in San Francisco, at Techau Tavern, on the evening of September 6.

The Arctic Club, located across Profontaine Square from headquarters, will keep open house to delegates. Dining room and ladies' dining room open all day. A limited number of rooms are available and delegates may secure the same by writing M. J. Falkenburg, Pioneer Square, Seattle.

A feature of the meeting will be two symposiums by the Industrial Division, one a general symposium completing the symposium at New Orleans and especially devoted to the progress of chemistry in special lines of chemical industry. Papers have been promised pointing out the influence of the chemist upon the following industries, and his accomplishments therein:

"Iron and Steel," George W. Sargent.
"Iron and Steel," A. S. Cushman.
"Perfumery," Alois von Isakovics.
"Perfumery," E. T. Beiser.
"Lead," G. W. Thompson.
"Paints and Varnishes," Maximilian Toch.
"Petroleum," David T. Day.
"Illuminating Gas," Sidney Mason.

A symposium will also be held on the distillation of wood, papers having been promised by the following experts in this line: J. R. Withrow, J. E. Teeple, Marc Darrin, Charles H. Herty, Bailey Tremper and Newton Critus.

The general program of the meeting is as follows:

Monday, August 30

7 P.M.—Council dinner.

Tuesday, August 31

10 A.M.—Address of welcome by Henry Suzzallo, president of University of Washington. Response by Charles H. Herty, president, American Chemical Society. Address, "Chemical Industry," by Dr. Leo H. Baekeland. Response, "Industrial Resources and Opportunities of the Pacific Northwest," by Dr. H. K. Benson.

1.30 P.M.—Symposium Industrial Division.

8 P.M.—Complimentary Smoker by Seattle Commercial Club.

Wednesday, September 1

10 A.M.—Division meetings, campus.

1.30 P.M.—Division meetings, campus.

4.30 P.M.—Automobile trip over boulevards.

8 P.M.—President's address, President Charles H. Herty. Business meeting.

Thursday, September 2

Excursion on Puget Sound.

8 P.M.—Subscription banquet (place to be arranged) price, $3.

Following are the addresses of the divisional secretaries:

Divisions:

Agricultural and Food Chemistry: G. F. Mason, H. J. Heinz Company, Pittsburgh, Pa.

Biological Chemistry: I. K. Phelps, Bureau of Chemistry, Washington, D. C.

Fertilizer Chemistry: B. F. Carpenter, Virginia-Carolina Chemical Company, Richmond, Va.

Industrial Chemists and Chemical Engineers: S. H. Salisbury, Jr., Lehigh University, South Bethlehem, Pa.

Organic Chemistry: C. G. Derick, 619 Indiana Ave, Urbana, Ill.

Pharmaceutical Chemistry: F. B. Eldred, Chairman, Eli Lilly & Company, Indianapolis, Ind.

Physical and Inorganic Chemistry: R. C. Wells, U. S. Geological Survey, Washington, D. C.

Section:

Water Sewage and Sanitation: Harry P. Corson, State Water Survey, Urbana, Illinois.

Abstracts of papers should be prepared and brought to the meeting, or, even better, sent to the secretary in advance thereof. Members sometimes fail to realize how important this is to the success of the society and to the proper advertisement of the meeting itself. Unless abstracts of the papers are brought to the meeting and early placed in the hands of the secretary, there is no opportunity for proper publicity in the local press, which is of very great advantage to the society. Members will greatly aid the secretary's office by remembering this fact. Articles not exceeding 100 words in length will be printed in SCIENCE.

The final program will be sent to all members of the Puget Sound Section, to members of the council, and to all members who make special request therefor by postal card to this office. The expense of printing and mailing this program is so great that it will be sent only to those who especially desire it on account of their intention of attending the meeting. Other members will find it printed in the society's journals.

CHARLES L. PARSONS,
Secretary

BOX 505, WASHINGTON, D. C.

SCIENTIFIC NOTES AND NEWS

THE Baumgärtner prize of the Vienna Academy of Sciences has been awarded to Dr. Heinrich Rubens, professor of experimental physics in the University of Berlin. Other prizes have been awarded to Dr. Gustav Herglotz, professor of mathematics at Leipzig, and to Dr. Wilhelm Trendelenburg, professor of physiology at Innsbruck.

PROFESSOR WILLETT G. MILLER, provincial geologist of Ontario, has been awarded the gold medal of the Institute of Mining and Metallurgy of Great Britain.

PROFESSOR R. A. MILLIKAN, of the Department of Physics, has been elected president of the University of Chicago Chapter of Phi Beta Kappa.

MR. H. W. MONCKTON, Dr. A. B. Rendle, Professor A. C. Seward and Dr. A. E. Shipley have been appointed vice-presidents of the Linnean Society for the ensuing year.

AT the last meeting of the general committee of the Imperial Cancer Research Fund Sir Thomas Barlow was nominated for election as an additional member of the executive committee, and Sir Rickman J. Godlee was elected a member of the general committee.

DR. WILHELM TRABERT has, on account of his health, retired from the chair of physics in the University of Vienna and from the directorship of the Bureau of Meteorology and Geodynamics.

DR. KARL REDLICH, professor of geology in the German Technical School at Prague, has been elected to be rector for the forthcoming year.

THE trustees of the Beit fellowships for scientific research, which were founded and endowed two years ago by Mr. Otto Beit in order to promote the advancement of science by means of research, have, as we learn from the

London *Times*, recently elected to fellowships the following: Mr. William Burgess Haines, B.Sc., of Leytonstone; Mr. Christopher K. Ingold, B.Sc., of Chiswick, and Mr. Henry N. Walsh, B.E., of Cork. Mr. Haines studied at University College, London, from 1907 to 1913; at the University of Göttingen, 1913–14; and has since been at the Imperial College. Mr. Ingold was an exhibitioner of the University of London in 1912, and a royal scholar in 1913; from 1911 to 1913 he was at the Hartley University College, Southampton. Mr. Walsh received his education in Ireland. He was a scholar, medallist and prizeman at University College, Cork, and is now assistant to Professor Alexander. The three fellows will carry on their respective researches in the Imperial College of Science and Technology.

MR. CHARLES F. BROOKS, of the U. S. Department of Agriculture, has visited the Weather Bureau and Agricultural Experiment Stations throughout the southern, western and central states to study the geographical distribution of farm enterprises, the distribution of farm labor throughout the year and the climatic element involved.

NELSON C. BROWN, professor of forest utilization in the New York State College of Forestry, is spending the summer in a study of forest utilization and management in the national forests which are maintained by the government in the Rockies and Cascades. He will secure material for class and laboratory work and for the Forestry Museum of the college.

PROFESSOR G. N. STEWART, director of the H. K. Cushing Laboratory of Experimental Medicine, Western Reserve University, is spending the summer in England. Dr. David Marine, associate professor of experimental medicine, has also gone abroad. He will be associated with Dr. Alexis Carrel in the study of wound infections at Compiègne, France.

MR. HENRY G. BRYANT, of Philadelphia, has returned from a journey which led him through the Panama Canal, down the west coast of South America with visits to Cuzco and La Paz, across the Andes and home via Buenos Aires and Rio de Janeiro.

AT the meeting of the Society for the Study of Inebriety held in the rooms of the Medical Society of London, on July 13, Major Leonard Darwin, president of the Eugenics Education Society, opened a discussion on alcoholism and eugenics.

THE annual meeting of the Society of Chemical Industry will be held at the Municipal School of Technology, London, on July 14–16, when Professor G. G. Henderson, will deliver the presidential address.

JOSEPH TARRIGAN MONELL, the St. Louis entomologist and mining engineer, has died at the age of fifty-eight years. The death has already been recorded in SCIENCE, but the name was incorrectly given.

COAL operators and miners in western Pennsylvania and West Virginia paid on July 15 tribute to the memory of Dr. Joseph A. Holmes, late chief of the United States Bureau of Mines, whose funeral was held in Washington on that day. Many mines suspended for an hour their work. The Pittsburgh experiment station of the bureau was closed.

MR. G. F. CHAMBERS, known for his numerous popular astronomical works, died on May 24, at the age of seventy-four years. Mr. Chambers was for a time one of the vice-presidents of the British Astronomical Society.

THE entomological collection of the Bureau of Science at Manila has been transferred to the University of the Philippines, and is now located in ample quarters at the College of Agriculture, Los Baños, Laguna, P. I., 65 kilometers from Manila by railroad. This collection, which contains most of the types of Philippine insects, described by European and American specialists during the past twelve or thirteen years, and containing, at present, more than 300,000 pinned specimens, together with alcoholic and biological material, will be materially increased in value by the collecting of faculty and students in the exceedingly rich faunal regions of Los Baños, Mt. Maquiling and Mt. Banahao. Mr. Charles S. Banks, as-

sociate professor of entomology and chief of the department, writes that entomologists visiting the Philippines will be cordially welcomed to the laboratories and every facility for their comfort will be placed at their disposal.

Explorations being made in the Westhaver mounds six miles south of Circleville by Curator William C. Mills, of the Ohio Archeological and Historical Museum, the Ohio State University, have brought to light interesting relics of aboriginal burial mounds. This mound is 16 feet high and 100 feet in diameter, about 2,000 cubic feet of earth, and every inch must be carefully examined. A total of fifteen burials was found in the mound, four of them in graves below the surface or base of the mound, and the remainder in the mound proper. In many cases the skeletons were found to be lacking one or more bones, and in one case the skull alone was found. This was explained by Dr. Mills as indicating the custom of reburial, practised by the mound builders. At one point in the explorations a huge grave was opened, extending five feet below the base line. In the grave were found three skeletons, placed side by side—two adults and a child. The adults, probably a man and a woman, were almost six feet in height, while the third skeleton was that of a child perhaps seven years old. Dr. Mills and his party will spend most of the summer working in this mound.

UNIVERSITY AND EDUCATIONAL NEWS

Professor C. H. Eigenmann has been reappointed research professor in zoology, Indiana University, for the year 1915–16. He will devote his time to the study of South American freshwater fishes.

At the University of Michigan, Dr. Alexander G. Ruthven has been promoted to the position of professor of zoology. He will retain the directorship of the Museum of Zoology.

The following promotions and appointments have been made by the trustees and medical faculty of Western Reserve University: William Evans Brunner, A.M., M.D., clinical professor of ophthalmology, to be professor of ophthalmology, with seat and vote in the faculty. H. H. McGregor, Ph.D., to be instructor in biochemistry; C. D. Christie, A.B., M.D., demonstrator of medicine and medical resident of Western Reserve University and Lakeside Hospital, to be director of the Clinical Research Laboratory at Lakeside Hospital, and Russell J. Collins, A.B., M.D., to be demonstrator of pharmacology.

In the University of Nebraska School of Medicine, Dr. Max Morse becomes assistant professor of biological chemistry.

C. E. Howell, of the University of Missouri, and E. B. Kranz, of Iowa State College, have been appointed to the division of animal husbandry at the State College of Washington.

Dr. Johannes Thiele, professor of chemistry at Strassburg, has declined a call to succeed Professor Wallach at Göttingen, and Dr. Friedrich Paschen, professor of physics at Tübingen, has likewise declined to succeed Professor Riecke in the same institution.

DISCUSSION AND CORRESPONDENCE

CANCER AND HEREDITY

In Dr. Slye's recent communication[1] concerning the inheritance of cancer, reference is made by way of illustration to a type of color inheritance which, since it is quite contrary to the more generally accepted principles of Mendelian inheritance, requires critical comment.

On page 160 she states "Let me at this point recall some of the basic facts of heredity." She then proceeds, using the customary Mendelian terms "*dominant*" and "*recessive*," to describe a cross between *gray and albino mice*, and indicates results which are incompatible with those of other investigators. She furthermore furnishes no data in support of this more or less revolutionary hypothesis.

As Castle, Allen, Bateson, Durham, Cuénot, Plate, Davenport, and many others have carried on investigations on this particular problem in genetics and have reached results contrary to those obtained by Slye, it seems rea-

[1] Slye, Maud, "The Incidence and Inheritability of Spontaneous Cancer in Mice," *Jour. of Med. Research*, 1915, XXXII., 159.

sonable to demand a full presentation of her data on the inheritance of *albinism* in mice. In fact, a careful repetition of such work should be expected before her claims are to be accepted.

To those unfamiliar with the work of the geneticists above mentioned, Slye's paper might be taken as presenting the well-known principles of Mendelian inheritance. With a knowledge of the facts, however, it is obvious that the type of inheritance which she outlines has not been observed in similar material by any of the investigators above mentioned. That this discrepancy is not based on an oversight on the part of Miss Slye has been determined by personal correspondence.

C. C. LITTLE

HARVARD UNIVERSITY

RADIUM FERTILIZER

IN a recent number of SCIENCE[1] there appeared an article by Hopkins and Sachs of the University of Illinois on "Radium Fertilizer in Field Tests" in which they gave results of a series of tests where they used .01, .1 and 1 milligram of radium per acre. Their results showed that radium used in these amounts had no effect.

It is well known that radium is present in all substances in slight traces. I thought it of interest to calculate the amount of radium in one acre. The question immediately arises, What is the volume of an acre? For agricultural purposes I think that every one will agree that the soil should be at least 5 inches, 12½ centimeters, deep.

There are 43,560 square feet in one acre. This when reduced to square centimeters is approximately 40,000,000 or 4×10^7. This when multiplied by the depth, 12½ is 5×10^8 cubic centimeters. Taking Rutherford's average value for the amount of radium in the crust of the earth as 2×10^{-12} grams radium per gram of material,[2] and calling the density of the soil, which is about 1.2, unity, and then multiplying 5×10^8 by 2×10^{-12} we have 1×10^{-3} grams or 1 milligram of radium in an acre of soil.

Thus Hopkins and Sachs in using their maximum amount, 1 milligram, at a cost of $100 only doubled the amount of radium in the soil. A fertilizer is on the market which contains radium, .05 to .08 microgram, or 5 to 8×10^{-8} grams to the pound. The company recommends one pound of the fertilizer to fifty square feet of soil. Fifty square feet of soil, figured as above, contains about 5×10^{-7} grams of radium. Thus the average soil contains ten times as much as they recommend in their fertilizer.

Besides the radium in the soil we have the radium emanation, a gas which slowly rises through the soil from the interior of the earth. Experiments show that about $1,000 \times 10^{-12}$ curies of radium emanation issue from every square meter of the earth's surface in an hour. (A curie of emanation is the amount of emanation which is in equilibrium with one gram of radium, or the amount which will collect in a closed vessel in 30 days when the vessel contains one gram of radium.) Every square centimeter of the earth's surface gives off $.1 \times 10^{-12}$ curies per hour, or $.0003 \times 10^{-12}$ curies per second. One curie equals about 4.8×10^5 gram seconds. (A gram second is the amount of radium emanation given off by a gram of radium in a second.) Then $.0003 \times 10^{-12}$ curies equals about 150×10^{-12} gram seconds, or the amount of radium emanation which is continually given off by 150×10^{-12} grams of radium.

Thus the amount of radium emanation given off by the soil is 50 to 100 times as much as that which is given off by the radium in the upper five-inch layer of the soil.

To double the emanation in the soil one must use about 75 milligrams of radium per acre at a cost of $7,500 per acre.

R. R. RAMSEY

DEPARTMENT OF PHYSICS,
INDIANA UNIVERSITY

[1] Vol. 41, p. 732, May 14, 1915.

[2] "Rutherford Radioactive Substances and Their Radiations," p. 650.

SUGAR-BEET MOSAIC

ALTHOUGH this disease of the sugar beet has been observed for more than a dozen years it

has not heretofore been described, so far as the writer is able to determine. It occurs chiefly in the middle and western portions of the United States and appears to be increasing from year to year in some localities. By actual count in a large number of commercial fields it affects from ten to twenty per cent. of the stand and thereby threatens to become a limiting factor in sugar-beet culture in some areas. It makes its appearance about mid-summer and is easily recognized by the following characteristic.

The leaves affected are mottled yellow and green. The spots are not always sharply defined, but usually shade into each other, giving the affected leaves a yellowish appearance. Frequently only a part of the leaves on the same beet are affected, at least during the early stages of the disease. The remaining leaves seem to be perfectly normal in color and growth. The leaves showing the disease symptoms vary in number from one to many on the same plant. They have shortened petioles, usually dwarfed and frequently thickened blades. The affected leaves, if numerous, generally occupy one side only of the beet crown and extend from the outer whorl on one side of the crown to or past the center. The normal leaves occupying the opposite side of the crown give to the beet top a one-sided appearance. Occasionally all the leaves of a mosaic beet show the characteristic symptoms mentioned above. This is generally the case at or near harvest time. The shortened petioles give the leaves a tufted appearance, as in the case of curly-top.

The root is dwarfed and often hairy, thereby further resembling curly-top. The affected beets usually persist until harvest time, but those attacked early in the season are too small to be of any commercial value. It is evident that the assimilative functions of the beet are seriously impaired, but the real cause of the disease is not yet known. As indicated above, there are several particulars in which the two diseases, curly-top and sugar-beet mosaic, are similar, but even though they are both frequently found in the same field, they are easily distinguished the one from the other. The writer has suggested sugar-beet mosaic as a tentative name for this disease. It is hoped that the investigations now under way will establish the real cause of the disease, enable us to find a practical remedy and suggest a more satisfactory name. C. O. Townsend

DELPHINUS AND PHOCÆNA IN THE DELAWARE

Occasionally cetaceans enter the Delaware and wander up into fresh water, though apparently not above tidal influence. On January 21, 1915, a dolphin (*Delphinus delphis*) was found at Riverton, New Jersey. It was about six feet in length. I examined it several days later, when the skeleton was shipped to Philadelphia, for the museum of the Academy. Though the dolphin has been taken in New York Harbor, and once at Ocean City in New Jersey in 1894, no other records of its occurrence in New Jersey limits have ever been given.

The harbor porpoise (*Phocæna phocæna*) has been credited with ascending various of the larger rivers of New Jersey, as well as the Delaware, though no actual identified specimens appear to have been noted. I only know of one, which was washed ashore above Bristol, Pennsylvania, during the summer of 1904. It had been floating about with the tides for some time previously, having been first located at Bordentown, New Jersey. It was a rather small specimen, and not preserved.

Henry W. Fowler
Academy of Natural Sciences of Philadelphia

SCIENTIFIC BOOKS

Guidebook of the Western United States: Part *A*, Northern Pacific Route, with a side trip to Yellowstone Park; Part *B*, Overland Route, with a side trip to Yellowstone Park; Part *C*, Santa Fe Route, with a side trip to Grand Canyon of the Colorado; Part *D*, Shasta Route and Coast Line; Bulletins 611, 612, 613, 614, respectively, United States Geological Survey. Washington, 1915.

The second of these is at hand and presumably is representative of the four in general

plan and make-up. The preface indicates their purpose in part as follows:

"The present stimulus given to travel in the home country will encourage many thousands of Americans to study geography at first hand. To make this study most profitable the traveler needs a handbook that will answer the questions that come to his mind so readily along the way. Furthermore, the aim of such a guide should be to stimulate the eye in the selection of the essentials in the scene that so rapidly unfolds itself in the crossing of the continent. In recognition of the opportunity afforded in 1915 to render service of this kind to an unusually large number of American citizens as well as to visitors from other countries, the United States Geological Survey has prepared a series of guidebooks covering four of the older railroad routes west of the Mississippi.

". . . The plan of the series is to present authoritative information that may enable the reader to realize adequately the scenic and material resources of the region he is traversing, to comprehend correctly the basis of its development, and above all to appreciate keenly the real value of the country he looks out upon, not as so many square miles of territory represented on the map in a railroad folder by meaningless spaces, but rather as land—real estate, if you please—varying widely in present appearance because differing largely in its history and characterized by even greater variation in values because possessing diversified natural resources. . . .

"Items of interest in civic development or references to significant epochs in the record of discovery and settlement may be interspersed with explanations of mountain and valley or statements of geologic history. . . .

"To this interpretation of our own country the United States Geological Survey brings the accumulated data of decades of pioneering investigation, and the present contribution is only one type of return to the public which has supported this scientific work under the federal government."

The volume is essentially a guide to what may be seen from the train windows. It is more especially devoted to geology and physiography and in the hands of any interested traveler should materially contribute to the value and pleasure of the trip; throughout it has been planned for readers with little or no geological training, yet it will be found exceedingly valuable by geologists who are traveling through the region and seeing as much as possible from the train window.

It consists of 244 pages, 49 plates of views and 25 maps which cover the route from Omaha to San Francisco and from Ogden to the boundary of Yellowstone Park. The maps are on a scale of about 8 miles to the inch; the country adjacent to the route is represented by contours with a 200-foot interval; all railroad stations are represented with their elevation and the miles are indicated by the crossties on the railroad line, every tenth being numbered. The geological formations are mapped, only the boundaries being given with a letter to indicate the member; in this way colors are avoided and the map is essentially a geographic one, not confusing to the traveler who is not geologically minded, but adequate to the geologist, with the help of the cross-sections given on many of the maps. The maps are so inserted in the text that they may be conveniently before the traveler while reading.

The text is a station-to-station itinerary. In it one finds much data on the population and history of towns, cost of railroad construction, on bridges, cuts and fills, location of early forts and settlements, history of mining camps and their production, discharge of streams and potential water power, irrigation, amounts of farm production, a random note on vegetation, archeology and fauna of Great Salt Lake. There is, however, more of geology and physiography than of these other topics. Large and numerous footnotes carry explanatory and supplementary data on the formations passed through and on their fossil contents, on the history of early settlers, battles with the Indians, the history of railroad building, etc. Much of this is popular in nature and for the traveler who is not scientifically trained.

While the description applies almost en-

tirely to the immediate route, notes are given on short side trips at two or three points. A list of 45 publications on the region and a glossary of geological terms are appended.

J. E. HYDE

WESTERN RESERVE UNIVERSITY

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES (NUMBER 7)

THE seventh number of volume 1 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *Nova Geminorum No. 2 as a Wolf-Rayet Star:* WALTER S. ADAMS and FRANCIS G. PEASE, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

A continuous series of observations on Nova Geminorum No. 2 has shown the development of the spectrum of this star through the successive stages characteristic of novæ into one very strongly resembling that of planetary nebulæ; and then by the gradual elimination of the nebular lines and their replacement by Wolf-Rayet bands, into a spectrum identical with this characteristic type of stellar spectra.

2. *The Ruling and Performance of a Ten-inch Diffraction Grating:* A. A. MICHELSON, Ryerson Physical Laboratory, University of Chicago.

A ten-inch grating (actual ruled surface 9.4 inches by 28 inches) having a theoretical resolving power of about 660,000 shows an actual power of about 600,000. The method of obtaining exact ruling is also discussed.

3. *A Singular Dark Marking on the Sky:* E. E. BARNARD, Yerkes Observatory, University of Chicago.

From a dark object in Cepheus and those in Taurus the author gets the impression that the interstellar spaces are suffused with a feeble nebulosity and that the dark marks are due to the projection upon this background of nearer dark, opaque objects.

4. *A Highly Sensitive Electrometer:* A. L. PARSON, Chemical Laboratory, University of California.

The principle of working in a condition approaching instability is used to increase greatly the sensitiveness of electrometer and obtain an instrument theoretically sensitive enough to detect 10^{-6} volt (though unsteadiness makes it as yet impossible to detect an isolated potential-difference of less than 3×10^{-5} volt).

5. *The Distribution and Functions of Tribal Societies among the Plains Indians: A Preliminary Report:* CLARK WISSLER, American Museum of Natural History, New York.

Field-work conducted by the writer and his associates in the American Museum of Natural History leads to the conclusion that the societies have spread from tribe to tribe by culture diffusion of a desultory kind; that certain features of organization are traceable to particular tribes, and no one tribe can be the originator of the society as a whole.

6. *The Determination of Surface-Tension:* T. W. RICHARDS and L. B. COOMBS, Wolcott Gibbs Memorial Laboratory, Harvard University.

Attention is called to various sources of error in the measurement and in the calculation of surface-tension by the capillary-tube method, an improved form of this method is described, a new correction for the meniscus is proposed, and exact measurements with a number of liquids are presented.

7. *An Exhibit in Physical Anthropology:* ALES HRDLIČKA, Division of Physical Anthropology, U. S. National Museum, Washington.

The exhibits prepared under the direction of the author for the exposition at San Diego are described briefly to indicate their breadth, their permanent value, and their capability of forming the foundation of an anthropological center.

8. *The Compressibilities of the Elements and Their Relations to Other Properties:* T. W. RICHARDS, Wolcott Gibbs Memorial Laboratory, Harvard University.

This paper records all the recent work on the compressibility of the elements performed at Harvard, reduced to the best available standard—the newly determined compressibility of mercury. It is pointed out that the reciprocals of the melting points are very closely associated with the coefficients of expansion, and that

both of these properties seem to be essentially connected with atomic volume and compressibility.

9. *Radial Velocities within the Great Nebula of Orion:* EDWIN B. FROST, Yerkes Observatory, University of Chicago.

We must alter our conceptions of the nebula as an enormous mass of quiescent gas, and regard it as seething with local whirlpools besides perhaps having a considerable motion of rotation as a whole.

10. *The Radial Velocities of the More Distant Stars:* WALTER S. ADAMS, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The radial velocity of stars increases rapidly with the proper motion, and only very gradually with the spectral type. This agrees with Eddington's hypothesis that the relation between velocity and spectral type may be a relation between velocity and distance.

11. *Localization of the Hereditary Material in the Germ Cells:* T. H. MORGAN, Department of Zoology, Columbia University.

The chromosomes not only furnish a mechanistic explanation of Mendelian heredity, but in the case of non-disjunction and in the case of the point-by-point correspondence between the linkage groups and the chromosomes, furnish a verifiable explanation of the results. In the case of crossing-over and of interference the chromosomes give us the only objective explanation of the results that has been as yet offered.

12. *Researches on the Chemical and Mineralogical Composition of Meteorites:* GEORGE P. MERRILL, Department of Geology, United States National Museum, Washington.

Abstract of extensive investigations which will appear as a memoir in the series of *Memoirs of the National Academy.*

13. *On the Representation of Arbitrary Functions by Definite Integrals:* W. B. FORD, Department of Mathematics, University of Michigan.

The function $f(x)$ is represented as the limit of a definite integral depending on a parameter when the parameter becomes infinite, or by a series of definite integrals.

14. *The Lymphocyte as a Factor in Natural and Induced Resistance to Transplanted Cancer:* JAMES B. MURPHY and JOHN J. MORTON, Rockefeller Institute for Medical Research, New York.

A marked increase in the circulating lymphocytes occurs after cancer-inoculation in mice with either a natural or induced immunity. When this lymphoid reaction is prevented by a previous destruction of the lymphoid tissue with X-ray the immune states are destroyed; hence the lymphocyte is a necessary factor in cancer immunity.

15. *Some Theorems connected with Irrational Numbers:* WILLIAM DUNCAN MACMILLAN, Department of Astronomy, University of Chicago.

The presence of the factors $i - j\gamma$ in the denominators of series arising in celestial mechanics does not affect the domain of convergence of the series, provided γ is a positive irrational number which satisfies a rather mild condition.

EDWIN BIDWELL WILSON

SPECIAL ARTICLES

ON HYDRATION AND "SOLUTION" IN GELATIN

I

THE importance of the swelling and of the "solution" of protein colloids for the interpretation of many biological phenomena has been emphasized repeatedly.[1] Thus, the laws governing the absorption of water by simple proteins like fibrin, gelatin, gluten, etc., and those governing the absorption of water by animal and plant tissues are identical. It has thus become possible to explain on a colloid-chemical basis not only the normal water content of cells and tissues, but also to account for the abnormally great absorption characteristic of excessive turgor, plasmoptysis, and edema. On the other hand, the changes characteristic of the "solution" of previously solid

[1] See Martin H. Fischer, "Œdema and Nephritis," second edition, New York (1915), where references to the older literature on this subject will be found.

colloids (as when gelatin "dissolves" under the influence of a rise in temperature) may be, and have been called upon to explain the origin of the albumin appearing in the urine in certain types of kidney disease, in the liquids which are squeezed off by heavily hydrated (edematous) tissues (the so-called "transudates"), etc.

On the basis of such concepts, excessive turgor, plasmolysis and edema may be defined as states of increased hydration of the (hydrophilic) body colloids, while albuminuria (when not simply due to gross rupture of blood and lymph vessels with escape of their contents) may be defined as a state of increased "solubility" of the kidney colloids. The causes of an edema or of an albuminuria are, in their turn, to be found in the condition or conditions which are capable of bringing about these physicochemical changes in the colloids of the body. As of dominant importance in this matter I have emphasized the abnormal production or accumulation of acid in the pathologically involved tissues, though as I have pointed out many times before, this need not be, and probably is not, the only cause for the observed colloid-chemical changes.

The almost constant association of edema with a "solution" of the body proteins (as, for example, a swelling of the kidney with an albuminuria) suggested from the first that the same cause might lie behind both. In order to prove that this is the case, I have not only described acid intoxication experiments on animals which result constantly in the production of an edema of the kidney (and other organs) and an albuminuria, but also observations on pure proteins (fibrin, gelatin, etc.) which show that the same acid which leads to the increased swelling also leads to "solution" of the proteins.

II

It is a commonly accepted view that the "solution" of a protein represents but the extreme of that which in lesser degree is called swelling. So far as I know, it has been held almost universally that sufficient hydration, results as a matter of course, in "solution." A warning against the general adoption of this view has been sounded before.[2]

I have recently been working on gelatins at concentrations and at temperatures near their gelatin and melting-points. Working in this region has yielded results which prove conclusively that *the phenomena of hydration (swelling) and of "solution" in protein gels, while frequently associated, are essentially different. Hydration is to be regarded as a change through which the protein enters into physicochemical combination with its solvent (water); "solution," as one which can be most easily understood at the present time as the expression of an increase in the degree of dispersion of the colloid.* The experiments show that the increase in degree of dispersion is, on the whole, antagonistic to the hydration process, in that more finely dispersed colloid particles seem incapable of holding as much water as coarser ones.

For the experiments I used a commercial gelatin very low in salts which previous experiments had shown to be capable of great swelling with maintenance of form. Even so dilute a mixture as an 0.8 to 0.9 per cent. solution of the stock gelatin would set into a solid mass when left to itself for a few hours at 25° C. The experiments were carried out with 2 per cent. gelatin. This formed a very stiff gel upon which the effects of different added substances were then studied. The conclusions from such studies may be summed up as follows:

1. The addition of acids and alkalies to gelatin markedly *decreases* its tendency to gel.

2. The addition of acid or alkali will not only prevent gelation of a liquid gelatin but it will at the same concentration make a solid gelatin liquefy.

3. The addition of proper amounts of various salts to acid- or alkali-gelatins which in themselves would never gel leads to their prompt gelation, in other words, the salts antagonize the liquefying action of the acid or alkali.

4. The salts show an optimum in their in-

[2] See Martin H. Fischer, "Œdema and Nephritis," second edition, 433, 444, New York (1915).

hibitive effects upon the liquefying influence of acids and alkalies.

5. At the same concentration different salts are unequally effective in their power of producing gelation in liquid acid- or alkali-gelatins. Speaking generally, trivalent radicals are more active in this regard than bivalent ones, and these than univalent ones.

6. A quantitative relationship exists between the liquefying power of an added acid and the antagonistic action upon this of a salt. Gelatin mixtures containing a definite concentration of some salt, and solid when a certain concentration of an acid is established in them, begin to soften and finally to liquefy as the acid concentration is raised.

7. Other substances besides acids and alkalies favor the liquefaction of gelatin. Urea, pyridin, and the amins are found in this group.

III

These experiments have a bearing upon certain problems in colloid-chemistry and in biology and medicine. Under the former heading they bring the first proof, as far as I know, that hydration and solution in proteins is not the same thing. We seem to be justified in the assumption that gelatin is a chemical substance capable of existing in different degrees of association or polymerization. Depending upon the temperature and other changes in its environment, the degree of this association, and hence the size of the particles of which the gelatin is composed, may be greatly varied. At higher temperatures, under the influence of acids and alkalies, etc., the particles become small, while under the reverse conditions they become larger. With these changes in size they change their physicochemical properties so that under the former circumstances they are liquid and clear, while under the latter they become solid and opalescent. The particles seem capable of absorbing most water (becoming most heavily hydrated) when they have a medium diameter. Entirely neutral gelatin (in which the particles are large) therefore absorbs some water, which on the addition of acid (which multiplies the particles and makes them smaller) is increased. On further addition of acid, however, the particles decrease in size to beyond that optimal for swelling. In this region the mixture, as a whole, begins to liquefy and shortly thereafter begins to show prominent evidences of going into "solution."

In "swelling" experiments this region corresponds with that where with progressive increases in the concentration of acid the steadily mounting curve of water absorption begins to fall. It really means that the division of the gelatin particles has progressed beyond the point at which they hold their greatest amount of water.

The addition of salts to gelatin increases the size of the particles and in so doing brings them back toward the region more nearly optimal for hydration. As the salt makes the gelatin stiffer its opalescence again increases.[3]

From a biological point of view these experiments bring renewed evidence of the protein nature of the reactions in living cells in which an antagonism is observed between acids (or alkalies) and neutral salts. They also show why with a gradually mounting degree of acid intoxication in living matter, more and more salt is necessary to keep the affected proteins in a given physical state; in other words, why in clinical medicine more than "physiological" salt solutions, namely, so-called "hypertonic" ones, must be used in order to reduce an edema, an albuminuria, or similar states. Why salts with bivalent or polyvalent radicals have so long been recognized as of special aid in these practical clinical problems is also evident from these experiments.

The experiments also explain why injured tissues pass, as a rule, through a primary period of swelling into a second one of softening. Under the influence of the acids (and similarly acting substances) brought into play by the injurious agents the tissues first swell, but as the acid content rises protein dissocia-

[3] As will be shown in another communication, most of these statements hold for other proteins also. It is well to emphasize even here, however, that the salts tend to increase the size of the particles and thus dominantly to *favor* hydration under certain circumstances only in gelatin.

tion becomes more prominent, betraying itself by the greater tendency of the tissues to liquefy and, since hydration is now less, by softening.

The experiments also bear upon the problem of digestion and that special phase of it known as autolysis. The first changes observable in these reactions consist of swelling, followed by softening and dissolution of the proteins acted upon. Acids and alkalies have long been known to favor these initial steps in proteolysis, while salts have been known to inhibit them. Their action has usually been laid to the effect upon the enzymes themselves. As has been pointed out before,[4] acids, alkalies and salts produce at least as large and probably their greatest effects upon the proteins undergoing digestion. The important practical and theoretical bearings such considerations have upon laboratory practise and in the every-day problems of the hanging of meat, its preservation by salting, the prevention of putrefaction, etc., is self-evident.

The experiments also reemphasize the necessity of interpreting in the simpler language of colloid-chemistry the mass of experimental material now jumbled under the heading of "permeability" studies. It means little to say that under the influence of acids or of substances which in living cells produce acid effects (like the anesthetics) the "permeability" of the "plasma" membranes surrounding cells is increased so that albumin gets out or salts get in. Not only are plasma membranes figments of the imagination, but nothing is gained by heaping "permeability" properties upon them. "Permeability" is a physiological concept which needs itself to be explained. The proteins throughout a cell (not only in its hypothetical overcoat) can under the influence of acids, for example, be made to absorb water, to absorb salt,[5] to soften and to give off albumin. And as all these effects can be reduced through the addition of various salts, there would seem to remain little reason to ignore for the interpretation of well-known biological facts the simple principles of colloid-chemistry.

Martin H. Fischer
Joseph Eichberg Laboratory of Physiology in the University of Cincinnati

[4] Martin H. Fischer and Gertrude Moore, *Am. Jour. of Physiol.*, 20, 330 (1907).

[5] Martin H. Fischer, *Jour. Am. Med. Assoc.*, 64, 325 (1915).

SOCIETIES AND ACADEMIES

SECTION OF BIOLOGY AND GEOLOGY

ACADEMY OF SCIENCE AND ART OF PITTSBURGH

During the year 1914–15 the Section of Biology and Geology of the Academy of Science and Art of Pittsburgh held fifteen meetings with an average attendance of about 150 members. The general topic under discussion was Evolution and the following papers were presented:

October 6, 1914. Dr. Frank Schlesinger, Director of the Allegheny Observatory: "Evolution of the Universe."

October 20. Professor Henry Leighton, of the University of Pittsburgh: "The Earth's History and Development."

November 3. Dr. Chas. R. Fettke, of the Carnegie Institute of Technology: "The History of the Rocks."

November 17. Dr. A. E. Ortmann, of the Carnegie Museum: "The Direct Evidence for Evolution."

December 1. Dr. O. E. Jennings, of the Carnegie Museum: "The Evolution and Ecology of Plants."

December 15. Dr. A. E. Ortmann: "Evolution in Animals."

January 5, 1915. Professor L. E. Griffin, of the University of Pittsburgh: "Embryology in its Relation to Evolution."

January 19. Dr. W. J. Holland, Director of the Carnegie Museum: "Paleontology."

February 2. Professor Roswell H. Johnson, of the University of Pittsburgh: "Experimental Evolution."

February 16. Mr. O. A. Peterson, of the Carnegie Museum: "The Evolution of Man."

March 2. Mr. George Seibel: "The Evolution of Society."

March 16. Professor L. E. Griffin: "Ant Behavior."

April 6. Professor Gardner C. Basset, of the University of Pittsburgh: "Heredity."

April 20. Dr. H. B. Davis, principal of the Training School for Teachers: "Evolution in Education."

May 18. Rev. Charles E. Snyder: "The Evolution of Religious Thought."

Charles R. Fettke,
Secretary

SCIENCE

FRIDAY, AUGUST 20, 1915.

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

SCIENCE AND CIVILIZATION

THE American Association for the Advancement of Science is sixty-seven years old. It has held annual meetings successively in the eastern centers of population and education, from Boston to Denver and from New Orleans to Toronto. We are to-day opening the first meeting of the association west of the Rocky Mountains. It gives a more correct impression to note that the Denver meeting of 1901 and the San Francisco meeting are the only ones thus far held west of the Mississippi River cities—in the western three fifths of the United States. The San Francisco meeting has been appointed with the double purpose of encouraging the development of science in the Pacific region and of uniting with other organizations in celebrating the completion of the Panama Canal.

There could scarcely be a better illustration of the relations of science to civilization than the canal supplies. This great waterway has been constructed, not so much by the potency of our national wealth in gold, not so much by the wonderful engineering and administrative ability which we all delight to honor, as by the victory of pure and applied science over the sources of malarial and yellow fever infection. Three centuries of research in the various branches of biology, as pure sciences, inaugurated by Vesalius's anatomical dissections (about 1530), by Harvey's discovery of the circulation of the blood (about 1616), by Hooker's introduction of the

[1] Address of the President, San Francisco meeting, August 2, 1915.

microscope (about 1665), by Leeuwenhoek's discovery of protozoa (1675) and indeed of bacteria (1687), and continued by a succession of unselfish men whose names are as household words to all biologists, had led up naturally to the mighty contributions of Pasteur, Lister and Koch in bacteriology. Then followed, logically, the investigations of Reed and others upon yellow fever infection, and of Laveran, Manson and Ross upon malarial infection. Except for such voluntary tests as were made at the peril of their lives by Doctors Lazear and Carroll in Cuba in the year 1900, in which Lazear paid the extreme penalty of death from yellow fever, and for the tests made by many other volunteers, especially in Italy, as to malaria, in order to determine the precise conditions under which certain mosquitoes transmit these diseases, the canal would not be complete to-day. Our government might not, in fact, have started upon its construction; or, if the government had started blindly to lead the blind, there would have been failure as miserable as that recorded by the French canal company, and for the same reason. We forget unpleasant facts quickly; for example: that of thirty-six brave French nurses who came together to the canal zone, only twelve returned to France; that out of eighteen ambitious young French engineers who crossed the Atlantic on the same ship for service on the canal, only one was alive at the end of thirty days; and that the laborers died by the thousands. The project of constructing the canal was surrendered to an unknown enemy. Let us assume, however, that such sacrifices had prevailed in their purpose and that the canal had been completed in accordance with the engineering plans. With malaria and yellow fever still ruling in the canal zone, and with the zone as a center of infection for all ports of the Atlantic and the Pacific, would a completed canal be a valued asset to commerce, or would it be a constant menace and a nuisance? Let Memphis and Havana and New Orleans answer. A grateful people could worthily erect by the Golden Gate a monument to Lazear, who gave all that he had to make the construction of the canal possible, and to make the completed canal of permanent value.

The minds of all thoughtful people are dwelling daily upon another great application of science—the European and world-wide war. During the past twelve months the resources of the leading European nations have been applied with the utmost intensity to purposes of destruction—to turning the hands of civilization backward. The most recent discoveries in science and the latest inventions are utilized in dealing death to the foe, from the air, from the land, from the sea, and from under the sea. It is a fact that the efficiency of the engines of death in all nations is measured by the state of science in those nations. By way of comment upon this lamentable truth, what shall we who advocate the advancement of science say for the faith that is in us? The prostitution of science to the killing and crippling of men is indeed an ugly fact, but its results are negligible in comparison with the daily ministrations of science to the people's needs. A conflagration may burn a great city; but the inhabitants of that city do not ask that fire, the most useful servant of the human race, shall be banished from their daily lives. The remarkable advance in the civilization of the leading nations during the past four centuries has been due, chiefly, to the hourly and daily influences of accurate knowledge and scientific method; and this advance has been made not by virtue of, but in spite of, wars and the implements of warfare. In this connection, let us note

that the scientific spirit is all but unknown among the Turks, the Moroccans, the Mohammedans in general, the Hindoos, the Egyptians, the Chinese. Amongst all of these peoples, comprising three fifths of the human race, can any one of us to-day recall the names of three men who have contributed appreciably to the advancement of science in the past two centuries? The very limited introduction of scientific method into their countries is the work of alien governors or alien influence. The unscientific nations are threatened with absorption by their more scientific neighbors, not so much because they do not invent or perfect the most powerful cannon, the sturdiest dreadnaught, the speediest aeroplane, or the subtlest submarine, as because the scientific peoples forge ahead of them in the arts of peace, in the modes of thought, in the affairs of daily life. The unscientific peoples are without influence in the world, not because they are unwarlike—the Turks and essentially all Mohammedans are warlike enough to suit the most exacting—but because they are lacking in the every-day efficiency which accompanies the scientific spirit.

The term science may be defined in several ways. From the standpoint which interests us to-day, we may say that science is the relationship of cause and effect. Wherever we observe an effect there has been a cause; wherever causes are operating there will be effects. The same causes, acting under precisely the same conditions, will produce precisely the same effects. This is the experience of every investigator in every subject, and no one has the slightest reason to doubt the correctness of the principle. There is no room for the operation of the arbitrary and the capricious; in fact, the arbitrary and the capricious do not exist in nature. If in one case out of a hundred the result which interests us is different from what we had expected we may rest assured that in this one case some change occurred in the forces acting; a new force entered, an old force became inoperative, or the relative intensities of the active forces changed. When we do not understand why certain events occurred it means that we do not understand the forces which acted to produce the events. The correct explanation of the events means that we have isolated the causes and have been able to express the laws of their action.

The forces which have interested mankind, range from those cosmic forces which operate on a scale so stupendous that we have no control over them, down through those forces which we can control to a limited extent, and on to those which are absolutely subject to human control. We are not able to limit or to increase the output of the sun's heat, and we can not guide the movements of the comets, planets and stars in their orbits. We do not know how to stay the wind and the rain, but we can apply them, in a limited degree, to our purposes, and we can do much to protect ourselves from their injurious effects. The forces which govern the daily life of the individual, the community and the nation, and which govern the relations of individuals, communities and nations to each other are, with rare exceptions, either absolutely under human control or such control is a hopeful aspect of the near future. These forces are the means to certain logical ends, and we can not question that they also operate unerringly according to law. Whether they shall be applied for civilization or against civilization is for man to decide. The automobile may be used to bring the physician on an errand of mercy, or to hasten the robber to a place of concealment and immunity. High explosives will cut a canal through the Culebra ridge, or deal destruction from a twelve-inch shell.

The American army may establish local self-government in Cuba from the highest of humanitarian motives, or it may wage a war of conquest on a weak neighboring country from the low motive of increasing the power of human slavery as a national institution.

From our experiences upon the earth we have learned to place faith in certain simple laws of nature, amongst which are the following:

1. Every particle of matter attracts every other particle of matter, in accordance with the law of gravitation.

2. Heat always flows from a hotter body to a colder body.

3. The volume of a given quantity of gas or vapor is a function of the temperature and pressure to which it is subjected.

If a rifle, elevated at a certain angle above the level surface of a lake, gives a certain muzzle velocity to the bullet, the bullet will describe the curve which the law of gravity says it should describe, and strike the water where the law says it should strike, provided we take into account two small factors that are also acting—the resistance of the air and the rotation of the earth.

A red-hot cannon ball and a red-hot bullet, thrown into a great bank of snow will both cool down to 32° Fahrenheit; the great cannon ball slowly and the little bullet rapidly.

A rubber balloon containing a given quantity of hydrogen gas can be so proportioned that if thrown from a high tower on a hot summer day it will expand and rise, or on a cold winter day it will contract and fall.

If a comet, a hundred million miles away, more or less, is observed very accurately as to its direction from us to-night, again next Monday night, and a third time in two weeks from to-night, Newton's law of gravitation will enable us to determine the curve in which the comet is traveling around the sun, and to say where the comet may be seen three months or six months later.

The great stars and the small stars radiate their heat energy into surrounding space: the great stars cool off extremely slowly, and the small stars comparatively rapidly. Examples of this principle, it is believed, are the great sun, on the one hand, its volume 1,300,000 times the earth's volume, its surface temperature higher than 10,000° Fahrenheit, and its interior temperature immensely higher yet; and the little earth, on the other hand, cool on the surface and relatively cool in the interior.

As the great gaseous suns radiate their heat energy unceasingly into surrounding space, they undoubtedly grow slowly smaller under the force of their own internal gravitation which strives constantly to pull each molecule of gaseous matter to the centers of the stars.

There is every reason to believe that the three simple laws which we have quoted and illustrated are fundamental, and operate invariably throughout the stellar universe.

And so it is, as far as human experience has gone, with all the laws of nature.

To some people this infallible and universal obedience to law—the strict accountability of effect to cause—seems a hard and cruel fact and counter to idealism in its various forms. This is a hasty and faulty view. It is the cause-and-effect relationship which gives us something dependable upon which to build our civilization. The recognition of this principle, whether conscious or unconscious, is the chief difference between modern civilization and the civilizations which prevailed in the days of the inquisition and of the Salem witchcraft. Looking at the subject from the idealistic standpoint, the conception that all matter in the universe is en-

dowed with the property of obeying law—unalterably obeying law—is incomparably grander than the conception of one law prevailing here, another law prevailing there, of irresponsible caprice operating both here and there.

History affords no more remarkable phenomenon than the retrograde movement in civilization which began with the decline of Roman power and continued for more than a thousand years, approximately to the epoch of the Borgias, Columbus and Copernicus. There had once existed a wonderful Greek civilization, but for twelve or fifteen centuries it was so nearly suppressed as to be without serious influence upon the life of the European people. Greek literature, one of the world's priceless possessions, not surpassed by the best modern literatures, was as complete two thousand years ago as it is to-day. Yet in the middle ages, if we except a few scattered churchmen, it was lost to the European world. A Greek science never existed. Now and then, it is true, a Greek philosopher taught that the earth is round, or that the earth revolves around the sun, or speculated upon the constitution of matter: but excepting the geometry of Euclid and Archimedes, we may say that nothing was proved and that no serious efforts were made to obtain proofs. There could be no scientific spirit in the Greek nation and civilization as long as the Greek religion lived and the Greek people and government consulted and were guided by the Greek oracles. If there had been a Greek science, equal in merit with modern science, think you that stupidity and superstition could have secured a strangle hold upon Greek civilization and have maintained a thousand years of ignorance and degradation? Intellectual life could not prosper in Europe as long as dogma in Italy, only 300 years ago, in the days of Bruno and Galileo, was able to say, "Animals, which move, have limbs and muscles; the earth has no limbs nor muscles, therefore it does not move;" or as long as dogma in Massachusetts, less than 250 years ago, was able to hang by the neck until dead the woman whom it charged with "giving a look toward the great meeting-house of Salem, and immediately a demon entered the house and tore down a part of the wainscoting." It was the rebirth of science, exemplified chiefly by astronomy, and secondarily by medicine, which gave to the people of Europe the power to dispel gradually the unthinkable conditions of the middle ages.

Shall we try to estimate what astronomy, an ideal science, sometimes called an unpractical science, has done for mankind? We shall not dwell upon its so-called practical applications, such as the supplying of accurate time, the sailing of ships precisely to their destinations on the other side of the great oceans, the making of accurate maps of the continents and islands, the running of boundary lines between nations, the predicting of times of high and low tides, and so on; we shall consider only the pure knowledge side of the subject.

Conceive of the earth as eternally shrouded in thick clouds so that the earth's dwellers could never see the sun, the moon, the stars and the nebulæ, but not so thick that the sun's energy could not penetrate to the soil and grow the crops. Under these conditions, we might know the earth's rock strata to the depth of a mile or two, we might know the mountains and the atmosphere to a height of two or three miles, we might acquire a knowledge of the oceans, but we should be creatures of exceedingly narrow limits. Our vision, our life, would be confined to a stratum of earth and air only four or five miles in thickness. It would be as if the human race went about its work of raising corn for food and cotton

for raiment, always looking down, never looking up, knowing nothing of the universe except an insignificant stratum of the little earth. This picture is only a moderately unfair view of life as it existed on our planet four hundred years ago, before the days of the telescope, the spectroscope and the photographic plate, and before the days of freedom of speech and thought. The earth is no longer flat, supported on the back of a great turtle which rests upon nothing; it is round, and we know why; and it revolves around the sun in exact obedience to law. The stars are not lanterns hung out in the sky by angels at night; they are suns, hundreds of millions of suns, each on the average comparable in size to our sun. Exists there an intelligent man in the world whose thoughts, every day and many times a day, are not adapted to these facts? Who can estimate the value of this knowledge to the human race?

We have not yet seen little earths revolving around any stars except our own, nor do we know that intelligent beings live upon such planets and are looking down toward our system and seeing our sun as a little star in their night sky; but everybody now holds as absurd the view that our star is the only one of the hundreds of millions of stars which has little planets revolving around it, or that our earth is the only one that is inhabited by intelligent life. Can there be a more inspiring thought than that intelligent beings are probably living here and there throughout the universe, in whatever direction we may look? The spectroscope has shown that the chemical elements which compose the earth are also the constituents of our sun and of the other suns. We have no reason to doubt that the chemistry of the earth is the chemistry of the universe. The spectroscope and the photographic plate are telling us of the close relationship of the nebulæ to those stars which we call the youngest stars, of the young stars to the middle-aged stars, and of the middle-aged stars to the old stars. We can not doubt that the stars are growing older, as we are growing older, as everything in nature is changing and growing older, and in accordance with the same laws which govern the changes on the earth. The student of double stars finds that the movements of the two components of a distant double star system are in accordance with the law of gravitation. Every particle of our experience leads us to believe that the reign of the laws which control our everyday affairs is universal; that the strict relationship of cause and effect applies throughout the stellar system. Does not this broad and stable foundation give valued confidence to those who are building the structure of the other sciences, the structure of everyday life, the structure of civilization?

The purpose of the American Association is the advancement of science in all its branches. Its scope is sufficiently broad to include every subject that is studied scientifically. Papers on the evolution of language, on the functions of governments, on the history of religions, if based upon the relations of cause and effect, have the same rights and privileges and the same welcome upon our programs as papers concerning the spectrum of the latest comet, the atomic weight of helium or the origin of volcanoes.

It is now quite difficult to find a subject that is not being studied scientifically somewhere by somebody. It is this fact which accounts for the phenomenal progress of civilization in the past half century, and especially in the last thirty years. With rare exceptions, all important interests are pulling together for the welfare of mankind, and their efforts are effective because they are advancing over the firm foundation of scientific method. Every branch of

science, every nation's literature or art, every element of "religion pure and undefiled," every element of commerce conducted upon the dignified basis of mutual respect and mutual profit of buyer and seller, is a contributor to the forward movement. It would be a pleasure to support this thesis by reference to definite contributions in many subjects, but time is available for only a few accomplishments of the past and a few needs of the future.

The discoveries in preventive and curative medicine undoubtedly rank amongst the most valued contributions to civilization in the entire range of scientific research. I am disposed to place the names of Louis Pasteur, Joseph Lister and Robert Koch very high on the list of the world's great benefactors. Pasteur was a professor of chemistry whose first investigations lay in the domain of abstract chemistry, and his subsequent successes, which put the world in the way of preventing and eradicating all infectious diseases, proceeded naturally from his application of the methods of research in pure chemistry to the problems of fermentation. He proved that wine, beer and milk ferment and turn sour because minute organisms, always present in the atmosphere, invade these liquids, multiply enormously and corrupt them. Break the skin of the grape, the atmospheric parasites enter the wound and fermentation develops. Exclude the air, or destroy the germs in the air, the wound in the vegetable structure remains clean and healthy indefinitely.

These discoveries by Pasteur attracted the immediate attention of Lister, who applied them in surgical operations. Antiseptic surgery, one of the most glorious works of man, is the result.

Pasteur proceeded upon the theory that just as fermentation is the work of foreign organisms, so certain diseases of animal life are the work of microbes which have entered the body of the sufferer. His first successes in preventive medicine related to cholera in the French fowls, and anthrax in the French cattle and sheep. His treatment reduced the death rate of the fowls and animals from about ten per cent. to less than one per cent. The great British authority, Thomas Huxley, estimated that the savings in these sources of wealth to the French nation in two decades were sufficient to pay the war indemnity of 1871. Proceeding further along the same lines, Pasteur inaugurated the curative treatment of hydrophobia. The fatalities from this horrible malady dropped suddenly from nearly one hundred per cent. to less than one per cent. Do we realize that this was only thirty years ago?

In the next three decades followed the preventive and curative treatments by several renowned investigators for diphtheria, tetanus, yellow fever, malaria, spinal meningitis, typhoid fever and other maladies. Progress has been notable in the treatment of tuberculosis, bubonic plague, cholera, typhus fever and sleeping sickness. There are faith and hope in the future as to preventives and cures for tuberculosis, scarlet fever, measles and cancer. The practise of extreme cleanliness and the use of anesthetics in surgery have enabled surgeons to reach hitherto inaccessible parts of the body, to reduce the death rate enormously, to diminish the suffering of the patient, and to afford health and strength after healing. Wonderful operations upon the brain, upon intestines, upon severed nerves, veins and arteries are now performed. The general health of communities has been improved by the theory and practise of cleanliness and fresh air. The average length of life has increased by many years since the principles discovered by Pasteur have been applied. The increase has been greatest for

children and women and those not in robust health, but it has also been great for those healthy men who have been accepted as risks by the life insurance companies. Life insurance business has been based upon mortality tables which represented the expectation of life under the relatively unhealthy conditions which existed a half century ago. Those tables do not fit modern conditions. The number of deaths is now smaller than the insurance tables predict. This means that the actual cost of insurance is correspondingly reduced. The statistics for the saving from this source are not readily available. It can be said, however, that the increase in the duration of the lives of those healthy men who carry insurance, during the past thirty years, has meant a money saving greater in amount than all the expenditures ever made by the universities, research institutes and individuals in support of medical investigation. This reckoning does not include the saving of the lives of women and children, nor take into account the economic values of the lives of the men, women and children saved. The reckoning likewise omits the vastly greater factor of human happiness which proceeds from healthful and complete family life.

We have referred at considerable length to progress in medical science and have said that this progress followed naturally from Pasteur's investigation of fermentation as a problem in pure chemistry. We do not intend to detract in any sense or to any extent from the glory of Pasteur's work, from the glory of Lister's, Koch's, Roux's, Behring's, Ross's, Ehrlich's and Flexner's services, when we record the simple fact that the structures which they erected and which mankind is finding of incalculable value were built upon the broad and firm foundations which the earlier investigators in biology and chemistry had made ready.

The development of the other subjects which have become so vital in modern life have essentially paralleled that of biology, chemistry and medicine.

It is so well known as to be a trite subject that electricity was studied a full century, following Volta and Galvani, before it was seriously applied to the arts. It is not so well known that the immense value of electricity in current life, as applied by the electrical engineers, is due chiefly to the work of two men: Faraday, in the Royal Institution of London, who, studying electricity as a pure science and with no apparent thought for its possible applications, discovered the principles of magneto electric currents, upon which all modern dynamos and transformers, electric lighting, telephoning and telegraphing, and the transmission of power depend; and Maxwell, of Cambridge University, who wrought Faraday's results into a foundation of complete and rigorous theory upon which future electrical engineers might build.

The X-rays and radium are the products of research in pure science, and quite regardless of so-called utility; yet what is to-day more useful than the X-rays, and what promises greater usefulness than radium and its related radio-active substances?

Pure science studies in the broad fields which we may call botany and chemistry have made scientific agriculture possible. We can not exaggerate the importance of science in farming for the future of the human race.

A few months ago the people of the Pacific coast acquired the power of telephoning directly to Atlantic coast points. Newspaper accounts made much of the fact as a great advance, and so it was; but the newspapers left Hamlet out of the play. Improvements in the insulating system, to reduce losses of current along the line, were

involved; but Bell at New York and Watson in San Francisco inaugurated the long-distance conversations by using the same transmitters and receivers which these same gentlemen had used in the beginning of telephoning, in 1876, over the line two miles long between Boston and Cambridge. The great improvements in the thirty-nine intervening years lie elsewhere in the system. It is possible for San Francisco to talk with New York and Boston, and at quite reasonable expense, because Professor Pupin, of Columbia University, as a result of systematic study, construction and test, discovered that by placing his invention, the so-called "loading coils," at certain appropriate intervals in an electric line, thus making what electricians call a suitable balance between inductance, electrostatic capacity and resistance, the current could be compelled to go through to its distant destination with little loss of strength. Pupin's loading coils are inserted at frequent intervals in the San Francisco-New York line. It might be possible to construct a line without the Pupin coils which would let us talk directly with New York, but the installation expenses for very large copper wires and other costly items would be so high as to impose prohibitive tolls. The happy result has been reached because the telephone company combined an exceedingly liberal and far-seeing policy with the latest discoveries in electricity as a pure and applied science; and all concerned are entitled to receive the grateful thanks of the Pacific and Atlantic peoples.

Wireless telegraphy has been a priceless servant to those whose friends go down to the sea in ships. It has averted many frightful disasters in the past decade. This branch of electricity was made possible by the researches of the lamented Herz and others who studied the properties of electrical waves as we study the light from the nebulæ—from the point of view of pure knowledge.

While the foundations of the sciences have, for the most part, been laid under the auspices of the universities and the special research institutions, it is usually the combination of men of science and successful men of affairs which makes the sciences useful to the people in general, and therefore great factors in the advancement of civilization. To mention only one subject, electricity: we can not compute the world's indebtedness to the pioneers, Volta and Galvani, nor to the great developers of the subject, Faraday and Maxwell; but it is a fact that electricity did relatively little for mankind in general before the year 1865. The world is unable to compute its indebtedness to Edison, Bell, Marconi and other great inventors and business men combined who have brought electricity to everybody's house and office, to every factory, to every village, to every ship as an obedient and ever-ready servant. That these gentlemen have made commercial successes of their ventures seems to have caused certain persons to lose interest in them as men of science. I have no sympathy with that point of view. Only those who have tried it can know how much courage is required to risk everything in a new venture, how many hours of day and night are given to thought of the subject from all possible angles, how unceasingly must be the maintenance of discipline in great business organizations. Not only is financial success doubly earned, and most desirable as an incentive to the succeeding generations, but financial success is absolutely synonymous with making the subject useful to mankind. It is a fortunate fact that there are Stephensons and Fultons, Edisons and Marconis, as well as Newtons and Laplaces, Darwins and Helmholtzes. The latter have laid the foundations broad and deep, but the former have

erected superstructures upon these foundations which the civilized world is using every minute with great advantage. And, further, these structures, which are visible in the daily life of the people, are the incentives which lead to the provision of splendid opportunities for the extension of the foundations. The value of science as a factor in advancing the race depends at least as much upon the applied as upon the theoretical side. There can be no durable structure without the foundation, but the foundation alone, possessing wonderful potentiality, is largely a latent force. History confirms the view that real progress in civilization is most rapid when applied knowledge is not too far behind theoretical knowledge.

There is a valuable lesson in this principle it seems to me, for the newly organized Pacific Division of the American Association; and perhaps I, as a representative of the most ideal of all the sciences, can with propriety outline the lesson. It is a fortunate thing that the astronomer, the geologist, the psychologist, each regards his pure science as the finest of all the sciences; it is easy to remember that medicine and surgery are returning many fold the financial support extended to them, and that agricultural science is a field of extreme need and promise; but what we should especially remember is this: a significant advance in science is not possible if the intellectual life and the physical life of the Pacific region people are seriously neglected. We should use the utmost endeavor to encourage the introduction of scientific method into the fields, the factories, the homes, the construction and care of roads, the improvement of waterways, the building of cities. There is something which every member of the Pacific Division can do to carry the leaven of scientific method into the life of his community. It is not excusable to be a pessimist, yet one can not travel, one can not be thoughtful, one can not be awake without seeing unscientific methods prevailing on every hand. Recall how often some one street in your town has been torn up for repaving in the last twenty-five years. Does the asphaltum on all the streets in your city remain firm and smooth, or does it become wrinkled and bumpy under the summer sun? Were the specifications for the asphaltum written by a man of science—a real engineer—or were the so-called improvements made under the auspices of the politicians?

There are a great many problems in the general government of our country, some of them of extreme importance, which ought to be solved along scientific lines and yet are not. The friends of high protective tariffs were in command of our government during several decades following the civil war. The friends of low tariffs, or tariffs for revenue only, when placed in command, made sudden reductions of considerable extent to meet their own views. Six years ago the schedules were sent up to record high levels, and four years later they were sent down to record low levels. The subjecting of business to such sudden changes and strains is unscientific in the extreme. We should say in fairness that the voters do not desire the schedules to fluctuate violently. No political party has received a mandate from the people in the last thirty years to revise the schedules to a new high level or to an extreme low level. The unhappy situation seems to be the fault of the machinery of control. The problem is a scientific one to which comparatively few members of congress have given conscientious study. All of the forces of interstate and international commerce are acting, not simply once in four years when the administration changes, but monthly and constantly. The schedules should be formu-

lated, in accordance with the country's adopted policy, by thoroughly trained and widely experienced students of economics; by a permanent commission, if you please, composed of the ablest economists that love of country and very high salaries will secure. These facts are recognized in many other countries, but not so by our governing forces. This is not a plea for high tariffs, or for low tariffs, or for moderate tariffs; it is a plea for reasonable stability of tariff schedules, and for a scientific treatment of the subject.

It would seem that the greatest need of the times is in the science of international relationships, to the end that truth and reason may replace deception and brute force. The word diplomacy should be rescued from the dictionary definition, "artful management with the view of securing advantages." The diplomat who seeks the advantage of his country at the expense of another is proceeding on immoral and unscientific lines, and the chances are strong that he is not a benefactor of the human race. He is liable to set in action forces of antagonism which were better not aroused. International settlements which are compelled by victorious war, or by the threat of a great army or a great navy in the background, settlements which do not take account of mutual interests, settlements which neglect the relations of causes and effects, are apt not to be settlements at all. They generally lead to unhappiness, retrogression and violence. It is a fearful comment upon diplomacy that Europe has had wars nine years out of ten since the beginnings of historical records.

It ought to be clear to historians that the forcible bringing into one country of a province, forcibly taken from an adjoining country, which speaks a different language and possesses different temperament and ideals, is in general a grievous mistake. It is usually a misfortune for both countries, especially if the two countries are of approximately the same degree of civilization. The repression of native language and customs, and the constant presence of alien governors, produce reactions which are as natural as the falling of an apple from the tree to the ground. If the economist is interested in balancing the finances of such a case he will seldom have difficulty in proving that the cost of holding the province for the conqueror is greater than the province is worth; and the cost of planning to get the province back is greater than the province is worth. The issues between the two countries are not settled by the process; they are left more unsettled than ever; and eventually the whole world may have to pay the cost of the false solution. It can not be pretended that wars in general settle international questions either justly or permanently; they merely repress certain forces until natural developments cause these forces to break out anew. A mistaken sense of national honor, usually combined with national selfishness, leads to settlements which are merely temporary. Settlements along scientific lines, settlements which consider cause and effect in the decades that are to follow, are so rare as to be negligible. There is scarcely any hope that the present inexcusable war will settle the differences between the nations, if the final adjustments are left to the professional diplomats of Europe. Some difficulties may be threshed out, but a new crop of difficulties will almost certainly be sown for a later generation to reap. It is an infinite pity that the plain lessons of history are so often forgetten in moments of international passion.

I should not like to have it thought that this is a plea for peace at any cost. I am speaking of war in general; there are exceptions when not to fight would be more

unfortunate than war; but just settlements of wars would go far to prevent war.

The human race needs above everything else the conviction that the principles of science rule everywhere, and that the problems of personal and national life are not solved so long as any important forces are ignored. The need is especially great in our own country where isolation from other countries and the existence of immense reservoirs of natural resources have let us seem to keep up with international progress in spite of our wasteful and inefficient methods. It were well to recognize that entry upon world affairs, which we can not long avoid, will reveal costly weaknesses.

The appeal of science for the adoption of scientific methods in the daily life of the people, in the governments of community, state and nation, in the settling of international questions, is not an appeal for efficiency at all costs. The life that is forever bent over the exact equation, two plus two are four, a life that tries to express all its experiences in equations equally exact, is liable to be narrow, distorted, unhappy and misspent. The man who worships scientific efficiency, like the man who is a slave to gold, or the man who pushes his religion too far, may acquire a harsh and selfish view of life; pity and charity may drop out of his vocabulary.

Our appeal is for the scientific method of treating the problems which are before us for solution. The scientific method is that which takes account of all the forces acting. It is therefore the just method. It is in full harmony with the Golden Rule, "Do unto others as you would have others do unto you." It is, if you please, in full harmony with the spirit of Christ. Support is given to research by the governments and by generous men and women in order that the truth may be found and be made available in the service of mankind. The investigational laboratories of the universities, the observatories, the private institutions for research, have precisely these ideal purposes, and no other purpose. The various activities of the world contribute to the advancement of civilization in proportion as they contain the ideal and the unselfish. That which is purely practical, containing no element of idealism, may sustain existence and to that extent be valuable, but it does not civilize. I believe it is the idealism of pure knowledge, the idealism in applied knowledge, the idealism in industry and commerce, the idealism in literature and art, the idealism in personal religion, which leavens the life of the world and pushes forward the boundaries of civilization.

W. W. Campbell

INDUSTRIAL ACCIDENT STATISTICS

The United States Bureau of Labor Statistics of the Department of Labor has just issued as Bulletin 157 a report on Industrial Accident Statistics by Frederick L. Hoffman. The adoption of the principle of workmen's compensation by more than half of the states within the last few years emphasizes the importance of the industrial accident problem and foreshadows the time when such compensation for industrial accidents will become universal throughout the United States.

As one method of measuring this importance, the bulletin presents an estimate of the number of fatal and nonfatal industrial accidents occurring among American wage-earners in a single year. The conclusion reached is that the number of fatal industrial accidents among American wage-earners, including both sexes, may be conservatively estimated at 25,000, and the number of injuries involving a disability of more than four weeks, using the ratio of Austrian experience, at approximately 700,000. These numbers, impressive as they are, fail to indicate fully the number of industrial accidents, for such studies as have already been made show that of the accidents involving disabilities of one day and over at

least three-fourths terminate during the first four weeks.

The industries which contribute the greatest number of fatal accidents are railroad employments and agricultural pursuits, each group being responsible for approximately 4,200 fatalities each year. Coal mining contributes more than 2,600, and building and construction work nearly 1,900. General manufacturing, while employing large numbers, produces only about 1,800 fatal accidents. When the fatality rates are considered, metal mining ranks as most hazardous, with a rate of 4.0 per 1,000, coal mining coming next with a rate of 3.5, and fisheries and navigation following with a rate of 3.0 per 1,000. Manufacturing industries as a whole rank lowest, with a rate of 0.25 per 1,000, but the fact should not be overlooked that this low average rate covers manufacturing groups varying widely in hazard, including, on the one hand, boiler making and the various departments of the iron and steel industry, in some of which fatality rates as high as those in metal and coal mining have prevailed, and, on the other hand, the textile and clothing industries, in some of which the risk of fatal accident is practically negligible.

These estimates are derived from the best sources available. At the present time there are no entirely complete and trustworthy industrial accident statistics for even a single important industry in the United States. This lack of trustworthy industrial accident statistics is due to the absence of any uniform requirements in the various states as to the reports of industrial accidents. Prior to the establishment of workmen's compensation systems, no state received reports of all the accidents, or even of all the fatal accidents in its industries.

THE AMERICAN SOCIETY OF AERONAUTIC ENGINEERS

THE American Society of Aeronautic Engineers, which was organized at the request of Mr. Thomas A. Edison, and which was requested by the secretary of the navy to appoint two members to serve on the navy's advisory board, has, after polling its members for their selection, nominated Messrs. Henry A. Wise Wood and Elmer A. Sperry, together with a special committee of the following aeronautic engineers and experts to cooperate with them:

> Orville Wright, Glenn H. Curtiss, W. Starling Burgess and Charles M. Manly, to advise on matters pertaining particularly to the theory and construction of aeroplanes and aeronautical motors.
>
> Peter Cooper Hewitt, John Hays Hammond, Jr., and Joseph A. Steinmetz, to advise on matters pertaining particularly to the application of aircraft for warfare.
>
> Captain Thomas S. Baldwin, A. Leo Stevens, Ralph H. Upson and Raymond B. Price, to advise on matters pertaining particularly to dirigibles, balloons and parachutes.

Messrs. Henry A. Wise Wood and Elmer A. Sperry constituted the popular selection, being nominated by eight tenths of the total votes. Both are scientific engineers, recipients of the Elliott Cresson and John Scott gold medals of the Franklin Institute, respectively, awarded for inventions of a basic character. Mr. Wood is president of the American Society of Aeronautic Engineers, vice-president of the Aero Club of America, and was a member of the aerodynamics laboratory committee appointed by President Taft in 1912. Mr. Elmer A. Sperry is vice-president of the American Society of Aeronautic Engineers. The Sperry gyroscopic stabilizer for aeroplanes in June, 1914, was awarded the first prize for safety devices of $10,000, by the French government.

The special committee of aeronautic engineers and experts was appointed as a result of many suggestions received from members of the society who, in sending in their selections, pointed out that no two men in aeronautics to-day have expert knowledge of every branch of the science of aeronautics. In most cases, therefore, they proposed additional names of experts in different branches of the science.

In the organization of the American Society of Aeronautic Engineers it was provided for the addition of directors to be appointed as

follows: Two by the army, two by the navy, one each by the Smithsonian Institution, the Post Office Department, the Weather Bureau, the Bureau of Standards, the Massachusetts Institute of Technology and the University of Michigan. The society has received a large number of applications for membership, but it is the intention of the executive board to apply the severe requirements of such technical societies as the American Institute of Electrical Engineers and the American Society of Mechanical Engineers in passing upon candidates for membership.

THE ORGANIZATION OF SCIENTIFIC RESEARCH IN GREAT BRITAIN

PARTICULARS of a "Scheme for the organization and development of scientific and industrial research" were issued on July 26 by the British Board of Education in a document signed by Mr. Arthur Henderson. The scheme is designed to establish a permanent organization, and it is pointed out that the research done should be for the kingdom as a whole, and that there should be complete liberty to utilize the most effective institutions and investigators available, irrespective of their location in England, Wales, Scotland or Ireland. There must, therefore, be a single fund for the assistance of research under a single responsible body.

The scheme provides for the establishment of:

a. A committee of the privy council responsible for the expenditure of any new moneys provided by parliament for scientific and industrial research;

b. A small advisory council responsible to the committee of council and composed mainly of eminent scientific men and men actually engaged in industries dependent upon scientific research.

The committee of council will consist of the lord president, the chancellor of the exchequer, the secretary for Scotland, the President of the Board of Trade, the president of the Board of Education (who will be vice-president of the committee), the chief secretary for Ireland, together with such other ministers and individual members of the council as it may be thought desirable to add.

The first non-official members of the committee will be: The Right Hon. Viscount Haldane of Cloan, O.M., K.T., F.R.S., The Right Hon. Arthur H. D. Acland, and The Right Hon. Joseph A. Pease, M.P.

The president of the board of education will answer in the House of Commons for the sub-head on the vote, which will be accounted for by the Treasury under Class IV., Vote 7, "Scientific Investigations, etc."

The first members of the Council will be: The Right Hon. Lord Rayleigh, O.M., F.R.S., LL.D., Mr. G. T. Beilby, F.R.S., LL.D., Mr. W. Duddell, F.R.S., Prof. B. Hopkinson, F.R.S., Prof. J. A. M'Clelland, F.R.S., Prof. R. Meldola, F.R.S., Mr. R. Threlfall, F.R.S., with Sir William S. M'Cormick, LL.D., as administrative chairman.

The scheme is designed to establish a permanent organization for the promotion of industrial and scientific research. It is in no way intended that it should replace or interfere with the arrangements which have been or may be made by the war office of the admiralty or ministry of munitions to obtain scientific advice and investigation in connection with the provision of munitions of war.

The primary functions of the advisory council will be to advise the committee of council on: (i) proposals for instituting specific researches; (ii) proposals for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; (iii) the establishment and award of research studentships and fellowships.

The advisory council will also be available, if requested, to advise the several education departments as to the steps which should be taken for increasing the supply of workers competent to undertake scientific research.

Arrangements will be made by which the council will keep in close touch with all government departments concerned with or interested in scientific research and by which the council will have regard to the research work

which is being done or may be done by the National Physical Laboratory.

It is planned that the advisory council should act in intimate cooperation with the Royal Society and the existing scientific or professional associations, societies and institutes, as well as with the universities, technical institutions and other institutions in which research is or can be efficiently conducted.

It is proposed to ask the Royal Society and the principal scientific and professional associations, societies, and institutes to undertake the function of initiating proposals for the consideration of the advisory council, and a regular procedure for inviting and collecting proposals will be established. The advisory council will also be at liberty to receive proposals from individuals and themselves to initiate proposals.

It is contemplated that the advisory council will work largely through sub-committees reinforced by suitable experts in the particular branch of science or industry concerned. On these sub-committees it would be desirable as far as possible to enlist the services of persons actually engaged in scientific trades and manufactures dependent on science.

The advisory council will proceed to frame a scheme or program for their own guidance in recommending proposals for research and for the guidance of the committee of council in allocating such state funds as may be available. This scheme will naturally be designed to operate over some years in advance, and in framing it the council must necessarily have due regard to the relative urgency of the problems requiring solution, the supply of trained researchers available for particular pieces of research, and the material facilities in the form of laboratories and equipment which are available or can be provided for specific researches.

Office accommodation and staff will be provided for the committee and council by the board of education.

SCIENTIFIC NOTES AND NEWS

THERE is published in this issue of SCIENCE the address of the president of the American Association for the Advancement of Science, Dr. W. W. Campbell. We hope to publish in subsequent issues other addresses given at the Pacific Coast meeting, together with reports of the proceedings of the sections.

FREDERIC WARD PUTNAM, emeritus professor of American ethnology and archeology in Harvard University, honorary curator of the Peabody Museum, permanent secretary of the American Association for the Advancement of Science from 1873 to 1898 and president of the association in 1898, distinguished for his contributions to anthropology, died at Cambridge, on August 14, in his seventy-seventh year.

JOHN ULRIC NEF, head of the department of chemistry in the University of Chicago, eminent for his contributions to organic chemistry, died on August 13 at the age of fifty-three years.

DR. FRANCIS X. MAHONEY has been appointed health commissioner of Boston.

THE Ontario government has appointed a commission to investigate the production and shipment of nickel in relation to the conditions created by the war. The members are Mr. G. T. Holloway, of London (chairman); Professor W. G. Miller, provincial geologist; Mr. McGregor Young, K.G., Toronto, and Mr. T. W. Gibson, deputy-minister of mines.

THE directors of British Dyes (Limited) are establishing a research department, and have invited Dr. G. T. Morgan, F.R.S., of the Royal College of Science for Ireland, Dublin, to become the head of the department. They have named a technical committee to consist of Dr. M. O. Forster, F.R.S., chairman, Dr. J. C. Cain, Dr. G. T. Morgan, F.R.S., and Mr. J. Turner. An advisory council, under the chairmanship of Professor Meldola, F.R.S., is also to be appointed.

DR. EDWARD W. RYAN, Scranton, chief of the American Red Cross in Belgrade, has been decorated by both the Serbian and French governments for his work in the hospitals where typhus fever has been raging.

DR. JOHN W. M. BUNKER, of the department of hygiene and sanitation, and sanitary in-

spector of Harvard University, has resigned to organize and direct the bacteriological research department of the Scientific Laboratories of the Digestive Ferments Co., Detroit, Mich.

E. S. Dickinson, formerly assistant professor of mining at the University of Kansas, has taken a position on the mining staff of the Canadian Copper Company at Copper Cliff, Ont.

Dr. L. H. Pennington, professor of forest pathology in the New York State College of Forestry, is spending the summer on the Pacific coast, where he is paying special attention to the work which the national government is doing in the control of diseases of forest trees on the national forests.

A monumental cross bearing the inscription "James F. Donnelly, staff physician, New York City, U. S. A," has been erected over the grave of Dr. Donnelly, who died while treating typhus fever in Serbia.

Dr. Thomas Stillman, the well-known chemical engineer, died of heart disease, on August 10, at the age of sixty-three years. Dr. Stillman was professor of analytical chemistry at the Stevens Institute of Technology for thirty-five years, retiring on a Carnegie pension in 1909.

Mr. H. S. Bion, assistant superintendent of the Geological Survey of India, died at Calcutta on June 6.

Mr. Herbert Kynaston, director of the Geological Survey of the Union of South Africa, died at Pretoria, on June 28, aged forty-six years.

Captain C. F. Balleine, fellow of Exeter College, Oxford, who had done work in archeology, was killed in Flanders on June 2.

Ernest Lee, lecturer in agricultural botany at the University of Leeds, has been killed in the war.

Dr. J. F. Eykman, professor of organic chemistry at Groningen, has died at the age of sixty-four years.

The death is announced of M. A. Arnaud, who occupied the chair of chemistry at the Museum of Natural History in Paris, and was distinguished for his work in chemistry and pharmacology.

Dr. Karl Kraepelin, formerly director of the Hamburg Natural History Museum, has died at the age of sixty-seven years.

The sixty-seventh annual session of the American Medical Association will be held at Detroit, June 12 to 16, 1916. The house of delegates will convene on June 12, and the scientific sections on June 13.

The petition of the Royal Astronomical Society has been granted, and a supplementary charter to permit the election of women as fellows and associates has been received. Proposals of women for admission as fellows can now be made.

Construction work on the new building of the Field Museum of Natural History, which is to be built on Chicago's lake front, just south of Twelfth street, began on July 15, after twelve years of planning and negotiation. The structure will be completed in less than three years, according to plans. More than 3,000 men will be employed in the work. It is said that it will be the largest marble building in the world and one of the largest museums. It will consist of three stories and a basement and will cover an area of 700 × 350 feet. The floor area of the museum will be 670,000 square feet, of which 400,000 square feet will be devoted to exhibition purposes. The remainder will be used for scientific laboratories, lecture halls, offices and a restaurant.

The children of William H. Singer, Pittsburgh, will erect a laboratory for investigations into the origin of disease, which will be operated in connection with the Allegheny General Hospital. The cost of construction, equipment and endowment will amount to $400,000.

Mr. J. S. Diller has been studying Lassen Peak on the ground in cooperation with officials of the Forest Service and has reported to the director of the geological survey as follows: "The great eruptions of Lassen Peak of May 20 and May 22 spent the energy of the old volcano and put a lid on it. The

effects of the flood on Hat Creek are being turned to good account, while many visitors are safely climbing the peak. Although it is possible that Vulcan is simply conserving his forces for a future outbreak, the general indications are that he is closing up the Lassen Peak branch of his laboratory for the season, perhaps with the intention of giving a small exhibit next spring when the snow melts."

UNIVERSITY AND EDUCATIONAL NEWS

DR. W. S. FRANKLIN has resigned from the professorship of physics in Lehigh University.

DR. JOHN LEE COULTER has been appointed dean of the College of Agriculture and director of the Experiment Station of the West Virginia University. He goes from the George Peabody College, and will take the place of E. D. Sanderson, who resigned about a year ago.

DR. OSCAR THEODORE SCHULTZ, formerly assistant professor of pathology in the medical school of Western Reserve University, has been appointed professor of pathology and bacteriology in the College of Medicine, University of Nebraska.

DR. JOHN N. SWAN has resigned his position in Monmouth College to accept the head professorship in chemistry in the University of Mississippi.

DR. E. L. TALBERT has been appointed secretary of admission in the University of Cincinnati, also giving the courses in social psychology.

JOHN JENKINS BUCHANAN, A.M., M.D., Ph.D., professor of surgery in the school of medicine, University of Pittsburgh, for the past fourteen years, has resigned his active teaching and has been elected professor emeritus. Robert Tablott Miller, A.B., M.D., for the past five years a member of the staff of the department of surgery of the school, lately holding the position of associate professor of surgery, has been promoted to the full professorship in charge of the department. Dr. Miller is a graduate of Amherst College and Johns Hopkins University Medical School. He held the position of resident on the surgical staff of the Johns Hopkins Hospital for a period of six years, following which he was elected to the position of instructor in surgery in the Johns Hopkins Medical School, which position he held for a period of two years, prior to his taking up his residence in Pittsburgh.

DR. J. R. SCHRAMM, assistant to the director of the Missouri Botanical Garden and instructor in botany at Washington University, has been appointed assistant professor of botany in the New York State College of Agriculture at Cornell University. Dr. Lester W. Sharp has been promoted to an assistant professorship in botany at the same institution. Other recent appointments in botany at the New York State College of Agriculture are as follows: J. Marshall Brannon, Albert R. Bechtel and Frank B. Wann, instructors; John P. Benson, Robert Stratton, Lawrence Erickson, George R. Gage and Harry E. Knowlton, assistants.

MR. HOWARD B. WAHA, who graduated in civil engineering from the Pennsylvania State College in 1909, and who has been employed in engineering work with the U. S. Forest Service in New Mexico and Arizona since graduation, has accepted the position of assistant professor of forest engineering in the New York State College of Forestry, Syracuse University.

W. A. ELLIS, a teaching fellow in the State College of Agriculture at Cornell University, has been elected instructor in forestry entomology. He will give his attention to insects affecting shade and forest trees of the state, and will assist Dr. M. W. Blackman, forest entomologist of the college.

PROFESSOR R. ROBINSON, of the University of Sydney, has been appointed to the newly constituted chair of organic chemistry at the University of Liverpool.

DR. HANS REICHENBACH, professor of hygiene at Göttingen, has declined a call to Halle.

DISCUSSION AND CORRESPONDENCE

PUBLIC HEALTH IN AMERICA

TO THE EDITOR OF SCIENCE: I was much interested in the article by Dr. W. W. Ford,

"The Present Status and Future of Hygiene or Public Health in America," read at the May, 1915, meeting of the Association of American Physicians, and published in SCIENCE, July 2, 1915. His presentation of the subject is an interesting exposition of the medical viewpoint and bias in public health, but many of his statements are dogmatic assertions, and are highly debatable; others are inconsistent with each other. For example, compare (page 11, column 1)

> . . . every medical school in this country should have its department or institute of hygiene. . . . It makes little difference whether the head of this department is a chemist, a bacteriologist or a physicist, since the problems of hygiene must be approached from various angles . . .,

and (page 11, column 2):

> It is essential that hygiene be presented as a distinct and independent science and not as a phase of bacteriology, or of chemistry, or of physics,

with (page 11, foot of column 2),

> Above all it must be remembered that hygiene is a medical subject and a part of medicine. Its methods are the methods of medicine . . .,

and with (page 12, column 2),

> . . . the health officer, be he city, county or state, has a distinct function, the intelligent exercise of which requires a medical training.

Surely if chemists, bacteriologists and physicists are competent to teach hygiene or public health (which is debatable), they should be competent to practise it; obviously if public health or hygiene is admitted to be a distinct and independent science, it can not be in the same breath a mere subsidiary of medicine.

Some of the main points in Dr. Ford's article must here go unchallenged for lack of space, but before proceeding to my main statement I wish to take up one minor point. He states (page 10, near bottom of column 2):

> The indifference to hygiene as a science lies in our universities and in our medical schools, and the responsibility for the failure of its development rests squarely upon them.

This is at least partly true, unless we wish to quibble as to whether public health is a science or the application of facts and principles of science. But the failure of the *practise* of public health rests squarely upon the medical profession. Led astray by idealism and zeal for the public welfare (some of the finest traits of the profession as a whole), they have offered their services as health officers in this country too often either without compensation or with very inadequate compensation. This has had a bad effect upon the public mind. Rightly or wrongly, the public tends to value things or services in proportion to the price they pay. This unselfishness by the profession will retard the development of public health in the future, as it has in the past, by making the public unwilling, until educated, to pay well for full-time technically trained health officers when they are able to get part of the time of an untrained practitioner-health-officer at nothing or next to nothing.

As has been well said before, we have heretofore chosen practitioners of medicine as our health officers because they came nearest of any class in the community to having the qualifications necessary for the work. As a matter for argument, I submit that practitioners of medicine lack much of the fundamental training and knowledge required for public health work, and some of their training and qualifications, except in unusual men, actually unfits them for true public health work, in part for the following reasons:

1. Public health is a function of government, not an appendage to the practise of medicine.

2. Public health is a distinct entity, an application of the facts and principles of various fundamental sciences to the *maintenance of health* and the *prevention of disease.*

3. Public health must be based on the facts of health and disease in the mass (in numbers, space and duration of time); the practise of medicine mainly upon individual cases.

4. The practise of medicine is an individual endeavor for private gain derived from individuals in a community; the practise of public health is a public endeavor by and for

the community, and paid for by the community.

5. Medical practise combined with public health service is an incompatibility.

Recently it has been argued that the training and experience of the sanitary engineer qualify him for public health work. As a matter of fact much of the sanitary engineer's training is exceedingly valuable in public health work, but the sanitary engineer as such is certainly no more qualified than the physician. The fact that several sanitary engineers have proved successful as administrative health officials by no means proves that the training of the sanitary engineer is the ideal foundation for public health work. The same arguments that have been presented for the sanitary engineer might be advanced for the training and qualifications of the attorney, the statistician, the chemist, the bacteriologist, the parasitologist, the veterinarian or the sociologist. All have labored in the field of public health, and all have at least some qualifications of great value.

Public health is now casting off the swaddling clothes of its infancy, and entering upon a period of vigorous youth. Medicine has been one of its parents, but now that the child is endeavoring to travel its own path we hear that parent uttering warning cries and, like all good parents, prophesying immediate or ultimate disaster if its rules and precepts are not heeded. For example, witness Dr. V. C. Vaughan's statements before the 1915 convention of the American Medical Association in San Francisco, and Dr. Ford's paragraph at the top of column 1 on page 13. We have heard several such utterances lately. Some we may suspect of having ulterior motives behind them; others, as the ones referred to, are admittedly cries of alarm on the part of the medical profession at the prospect of a fancied loss of prestige and influence.

In the last analysis the highest type of public health official will be a statesman, an administrator, an educator, above all an efficient public executive. He will have a broad public vision, partly from native qualifications, but developed by a broad training in public health *as such*, which will include much that is in medicine, but leave out much of medical training; which will include all that is essential in sanitary engineering, law, sociology, and the various fundamental sciences such as chemistry, biology, bacteriology, etc. He will also have an excellent foundation of general culture. He will superintend the work of physicians, engineers, statisticians, chemists, bacteriologists, attorneys, veterinarians and the like employed for special limited but intensive fields in public health, and will be the guiding hand in shaping public policy with respect to health. His life work, training and ideal will be public health, not private practise with public health on the side.

I realize that in thus criticizing some of Dr. Ford's statements I also have relapsed into dogmatic statements. This is difficult to avoid in the brief space of a letter, where proof would require a volume. I hope, however, that I have been able to show that certain viewpoints and theories in public health are debatable, and to have presented briefly a different, and I hope a better viewpoint.

Harold F. Gray
Board of Public Safety,
Palo Alto, Cal.

THE ATTITUDE OF THE STATE OF CALIFORNIA TOWARD SCIENTIFIC RESEARCH

The note on the Scripps Institution for Biological Research which appeared in Science, June 18, 1915, contains the statement that the state of California contributes $7,500 a year toward the support of the institution. This should be amended to the extent of saying that at the last session of the legislature, which adjourned a few weeks ago, the contribution was increased by $5,000, thus making the income of the institution from the state after July 1, 1915, $12,500 a year.

This discrepancy in statement is too small a matter to be in itself worth noticing, but as indicative of the attitude of the state toward the institution and toward scientific investigation generally, it is quite deserving of notice.

Two years ago when the first allotment was made by the state to the university for the

institution, and this year when an increase was asked, representatives of the state in both its legislative and executive branches charged with the task of preparing the budget for maintaining the state institutions during the ensuing biennium visited the institution, went over with the scientific staff and business manager in considerable particularity the work being prosecuted, and were unequivocally assured that the problems under investigation are all first and foremost scientific, and that only some of them might be expected to have a money value to the state.

Great emphasis was, however, laid by the men of the institution on the two facts that all increase of knowledge of nature is capable of being made useful to the people of the commonwealth in one way and another, either for their enlightenment or pleasure or material gain; and that the institution holds itself under as much obligation to make its discoveries utilizable in some form, as it does to prosecute the investigations themselves.

The attempt has always been made to impress upon officials and public that this institution is one in which private benefaction wishes to join with state benefaction for serving the community through *research in pure science*. And it is pleasant to record that the officers of the state government have been found to be at least not less responsive to the appeals for financial aid than have been the president and regents of the university.

Mr. John F. Neylan, chairman of the state board of control has taken the pains to expressly state that the placing of the institution's item specifically in the allotments to the university, which allotment is in turn a permanent element in the state budget of running expenses, should be understood to mean that the state accepts the institution with its avowed commitment to research as a definite and perpetual charge upon the state. And from Mr. H. W. Wright, chairman of the ways and means committee of the last assembly, comes the declaration: "We recognize that the state must support institutions of this kind."

From what California has done toward maintaining the Lick Observatory through a considerable term of years, and is now doing for the Scripps Institution, the conclusion seems justified that the state is definitely committed to the principle of state aid to scientific research, even though such research has no direct and primary industrial aims. In discussing these matters with officials, I stoutly contend that in the long run about the most telling criterion of success of popular government will be the extent to which it contributes to the highest development, spiritual and physical, of the naturally best endowed persons who live under and who participate in such government. The facts and reasonings that can be presented in support of this proposition, particularly those touching the question of leadership in scientific discovery, seem to appeal with special force to men grappling earnestly with the practical problems of government for a modern community.

Experience strongly inclines me to the view that the serious derelection of our national and several state governments in the support of scientific investigation is chargeable quite as much to scientific men themselves as to government officers and the people at large.

WM. E. RITTER

LA JOLLA, CALIFORNIA

A REPLY TO DR. LITTLE

IF we are ever able to discover what part hybridization plays in evolution, it is immeasurably more valuable to find out the behavior of natural species rather than of forms created in the laboratory under more or less artificial conditions, and which are never found outside the laboratory. This effort to place hybridization among evolutionary causes has been one of the chief aims of students of heredity.

My repetition of the standard cross between grays and albinos to discover the behavior of coat color in mice was carried on with wild housemice and not with artificial laboratory grays.

It is still open to question whether the wild housemouse (*Mus musculus*) inevitably fur-

nishes actual "homozygotes" which will stand every test of the theoretical "homozygote." Tower's work with chrysomelid beetles gives him pure-breeding species which behave as *homozygotes* in one hybrid cross with other pure breeding species, and as heterozygotes in other such crosses; and this order controlled environmental conditions never equalled in experiments with mice.

Moreover, the assumption of the exact similarity of every first generation hybrid in a given cross with respect to a given "unit character" leaves no place in nature for variation in any "unit character." Variation therefore would become wholly a matter of environment.

The divergence from the accepted canon of my results of color transmission in crossing wild housemice with laboratory albinos, involves a difference of data which in no way affects the question of the transmission of cancer.

Moreover, it is increasingly difficult to know the established canon in the behavior of characters in heredity. Exceptions to what was the canon have become so numerous as to be a part of the rule; and Riddle's work on melanin formation makes it particularly dangerous to be dogmatic on the transmission of such pigmentation in heredity, particularly in mammalian species where pigment is melanin.

My attack upon the problem of the inheritability of cancer was made almost with the sole end of solving the *practical questions as to its* inheritability and its nature, in order that we might get light upon the methods for its prevention and its cure, since these facts are so desperately needed.

In the face of the tremendous difficulties which the study of these things involve, it is essential that all minor considerations should be laid aside. It is essential also that the presentation of results should be simplified as much as possible and be kept as free as they can be from the disputes involved in the study of general problems in heredity. These details are not desired by the two classes most concerned, viz., humanity, who suffers from cancer, and the medical *profession* who must deal with it.

My practical results in the matter of the inheritability of cancer are these:

1. I have established strains of mice which neither in inbreeding nor in crosses with other noncancer-bearing strains ever in any generation have produced cancer.

2. I have made hybrid crosses between cancerous and non-cancerous individuals and have extracted from such crosses lines of mice which neither in inbreeding nor in hybridization with other non-cancer-bearing strains of mice have ever afterward shown cancer.

3. I have produced a cancer strain in which every member (of a reasonable cancer age) still living after my cancer work began bred true to cancer, and carried it into every strain with which it was ever hybridized.

4. I have extracted from crosses between cancerous and non-cancerous mice, lives which produce as high a per cent. of cancer-bearing individuals as it is reasonable to expect in dealing with a characteristic like cancer which may not appear until a mouse is three years old or even more. Many of these mice in cancer strains inevitably die of other causes before the right provocation has induced cancer in them. But the *hybridization test* has shown them cancerous potentially, for they transmitted it to their offspring.

This test, of course, has not been made with every individual. To subject every individual in every strain to every test is obviously impossible. The best one can do is to make a reasonable number of such tests, the object being to give to the medical world as quickly as possible the evident facts.

The production of about a thousand spontaneous cancers in specified strains, and the non-occurrence among this entire number of any cancer in certain other specified strains, no matter what test is applied to them, demonstrates to every reasonable probability the inheritability of cancer, and when these results are characteristically and systematically obtained in such an immense stock as to furnish over ten thousand autopsies and a living stock of about eleven thousand mice, with a steady production of between seventy-five and a hun-

dred cancer patients all the time and almost without exception within proved cancer strains, this reasonable probability is raised to an almost indisputable fact; and whether or not my strains of housemice have behaved in hybrid crosses in accordance with the established canon has no bearing whatever upon the behavior of cancer. It is an academic dispute which lies in quite another field.

In regard to my use of the terms "dominant" and "recessive" with respect to cancer behavior: it is almost the established conviction to-day that these terms are descriptive and not dynamic, and they furnish in the description of the behavior of cancer in heredity a graphic and convenient tool. That is probably all they furnish in the exposition of any problem in heredity. They may be discarded for even that service within the next few years.

The chief value in the study of cancer of the use of a partial Mendelian background of comparison (although the details may be under dispute) is to show to those most interested how far back in a strain cancer may lie and still be transmitted, and by what sorts of crosses this can be done, and to make it plain that in deciding upon the inheritability of human cancer and of the method of elimination of cancer from a family, one can not take as a criterion of judgment whether or not the immediate parents exhibited cancer.

I do not desire or make a strict Mendelian interpretation of my results, indeed I should deplore such an interpretation. I have used Mendelian comparisons (1) to make clear the influence of a more or less remote ancestry upon later generations of progeny; (2) to show how cancer, like albinism, has been transmitted in my strains through generation after generation by individuals who did not exhibit it; and (3) to demonstrate how cancer thus transmitted finally leaps into expression in the offspring of a pair neither of whom expresses cancer, but both of whom bear it potentially.

The approximation to even the most conservative Mendelian expectation is strikingly close for such a characteristic as cancer.

MAUD SLYE

THE OTHO S. A. SPRAGUE
MEMORIAL INSTITUTE

SCIENTIFIC BOOKS

The Mathematical Theory of Investment. By E. B. SKINNER. Boston, Ginn and Company, 1913. Pp. ix + 245.

Skinner's Theory of Investment is divided into four parts: 1. Algebraic Introduction. 2. Interest and Annuities. 3. Probability and Its Applications to Financial Problems. 4. Tables.

The Algebraic Introduction gives a sketch of arithmetic and geometric progressions, limits, series in general (with particular emphasis upon the binominal, exponential and logarithmic series), logarithms and graphical representation.

In the discussion of Interest and Annuities, the old standard problems are taken up, including such applications as amortization, the valuation of bonds, sinking funds, depreciation, building and loan associations.

In the third part a short introduction to the theory of probability precedes the discussion of life annuities and some other problems in life insurance.

There are 12 tables, mostly 7 place, for dealing with interest (simple or compound), discounts, and present values, annuities, and life insurance data.

This work is elementary, clearly written and satisfactory throughout for a general introduction to the problems with which it deals. In regard to insurance, one finds just about enough for an introduction without too much to take the cream off a real course in insurance. The subject of interest and annuities, however, is handled in such detail that further work upon the subject might not be needed.

The work is entirely formal, that is to say, no reference is made to economic conditions which affect the real rate of interest. The question, for instance, of the price level is not mentioned. No theory of interest can be other than mere form, without substance, apart from a discussion of the effect of a change of price level upon the investment yield, both as to principal and interest.

In discussing the valuation of mining properties the author says: "When a sum of money is loaned the person making the loan not only receives interest at a stipulated rate at the

end of each year, but at the end of a stated period he receives his original capital back again in full. There are, however, some forms of investment where the original capital is not returned to the investor. In such cases provision must be made for the redemption of the capital by setting aside some portion of the annual income as a redemption fund. A mine is a typical form of investment," etc. Now there is very serious objection to all this great detail and clearness on a subject which is not at all clear. You can not value a mine properly unless you know the price at which the product will be sold, and even then unless you know the amount of ore the mine contains, and the difficulty or ease of mining it. The impression is given that the mine will run out; what justification have we for such an impression? In the case of porphyry deposit of copper, where the total tonnage can be properly estimated, we can perhaps undertake to find some value of a mine. In the case of vein mines, however, there is no such possibility. Some mines have been worked for hundreds of years and are apparently richer to-day than ever before (Tintos, for example).

Moreover may it not be the rule rather than the exception that capital is not returned?

The average price level has risen so rapidly in the last fifteen years that a person who put his money out on loan fifteen years ago and received it back now, would have, in purchasing power, not more than one half to two thirds of that which he loaned. For the author, he would have his original capital back in full. From an economic point of view, he would have a very highly depreciated capital returned to him. He would be no better off than if he had invested in a mine, that was a mine, fifteen years ago—probably much worse off.

We realize fully that it is not in the province of the elementary book which Skinner has written to go into every sort of detail in regard to investments, but it does seem to us as though a short account of the bearing of the major economic phenomena upon investment should be included.

EDWIN BIDWELL WILSON
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Prehistoric Man and His Story. By PROFESSOR G. F. SCOTT ELLIOT. London, Seeley, Service & Co., 1915. Pp. 16, 398; illustrations and diagrams 64.

This is the second book by British authors on the general subject of prehistoric man to appear in 1915. The present volume however differs so widely from the one by Sollas that there is room for both. Besides the work by Elliot includes chapters on the neolithic period and the age of metals. Both agree in devoting much space to a comparison between prehistoric archeology and the ethnology of living primitive races.

In the initial chapter, on the preparation of the earth, it is pointed out that remains of lemurs have been found in the Eocene of North America and Europe, and the question is raised whether a "generalized lemur-monkey-man" could have lived at the time. If so he could have wandered all over the northern hemisphere from San Francisco to New Jersey, also from England to Japan. The climate was warm but not oppressively hot. As to food the land would have been considered a paradise by any living primitive race. The Miocene descendants of the common Eocene ancestor would have had to contend with carnivorous animals.

A discussion of "*Homosimius precursor*" naturally leads to the question of eoliths. These are flints of various ages which "have certainly been struck or chipped in an unusual way." While it is still not possible to say whether (or not) they were utilized by man, the author believes the evidence in favor of the artifact nature of some of the eoliths is more weighty than that to the contrary.

The next three chapters are devoted to missing links, the human body, and the limit of humanity. As one might expect, comparison of the brains of apes and of men shows considerable differences; on the whole, however, the general likeness is more striking than the contrasts. The differences between man and his Pliocene ancestor is "clearly in brain rather than in eyesight or manual dexterity."

The author is a monogenist and also adheres to the orthodox belief that the Old

World was the first home of man. There he invented his first tools and became acquainted with the use of fire. How were the first grass and forest fires produced; by a flash of lightning or a lava flow? Perhaps! but this can not have been a common origin, for the lightning is usually followed by heavy rain. Early man would flee from volcanic eruptions and run to some secluded spot during a thunderstorm. Neither occasion would be suitable for first experiments in the use and control of fire. Theobald states that forests in southern India are often set on fire through friction produced by one bamboo branch rubbing against another. It is likewise known that the Negritoes of Zambales still make fire by rubbing one bamboo across a nick in another. This was probably the first method employed by early man in the production of fire. The discovery of how to make fire came early and like the advent of the tool-using habit in general had a profound influence on the subsequent fortunes of mankind. How long ago these momentous steps were taken is not definitely known. The author thinks it might have been as far back as Pliocene times.

The rather short chapter on the glacial epochs is supplemented by a chronological table, from which it is seen that Elliot differs widely from Sollas. He accepts the Penck system of four glacial epochs with alternating warm episodes and would place the first known Europeans, *Eoanthropus dawsoni* and *Homo heidelbergensis*, in the first of these interglacial epochs, viz., the Günz-Mindel (Penck and also Obermaier would place them in the second). The Chellean, the first cultural epoch, eoliths excepted, is for the author synchronous with the second or Mindel-Riss interglacial epoch. In this he agrees with Penck and Geikie; but differs from Obermaier and Sollas who believe that the Chellean belongs to the third interglacial epoch (Riss-Würm). The differences of opinion appear still more pronounced when the attempt is made to express length of time in terms of years. For Sollas the Chellean epoch closed only about 27,000 years ago. This same lapse of time the author would estimate at more than 150,000 years.

In discussing the races subsequent to that of Neandertal, the author's statements are liable to confuse the reader. On page 121 he states that the "Aurignacians seem to have lived on in Europe through the Würm Ice Age, becoming in course of time the Magdalenians (or race of Cromagnon)." On page 163 he likewise speaks of the Cromagnon people as Magdalenian ("Madeleinian"). But on the following page one reads: "Yet the Aurignacians, or men of Cromagnon, were a primitive people," etc. Again on page 177 the race of Cromagnon is called Aurignacian.

In that part of the book devoted to paleolithic man, the use of such titles for chapter headings as "The First Herdsmen" and "The First Harvest" might lead the unwary to suppose that the domestication of animals and plants was a paleolithic achievement. The author does not think there is a "single paleolithic engraving of any of the cat tribe." Such engravings are rare but they are not unknown. On page 297 one is led to infer that the 840 basketry patterns of the Pomo Indians of California are prehistoric.

Letters, numbers, weights, etc., come in for interesting treatment, the conclusion being that not only the cup-and-ring marks but also a whole series of letters, number-signs, and others were handed on from the paleolithic to their neolithic successors; and that perhaps it is to the paleolithic period that we have to look for the origin of reading, writing and arithmetic.

Of the twenty-four plates, ten are from Rutot's reconstructions of early races; and twenty-two of the thirty-eight text-figures are from *Childhood of Man* by Frobenius. Useful references and footnotes are assembled at the end of each chapter. The author has read widely and traveled extensively. The transmission of his experiences is aided by a luminous imagination. If he has a fault it lies in a too-ready apparent acceptance of data, the value of which is still in the realm of the uncertain.

GEORGE GRANT MACCURDY
YALE UNIVERSITY

NOTES ON METEOROLOGY AND CLIMATOLOGY

CLIMATIC PROVINCES OF THE PACIFIC COAST

THE primary control of the Pacific coast climates rests with the ocean and the almost continuous westerly winds. Since the ocean has practically the same temperature all along the coast, the north and south temperature gradients on land are gentle. On the other hand, the mountain ranges paralleling the coast bring about sharp transitions in an east-west line—so that in summer one may pass in a few hours from the cold coast to a hot interior valley. The ocean, the west wind, and the mountains, thus, make the climatic provinces into belts roughly parallel to the coast. These belts may be subdivided on the basis of rainfall, which decreases rapidly from north to south. Mr. W. G. Reed has ably discussed and mapped such a distribution of climatic provinces in the January, 1915, *Bulletin of the American Geographical Society* (pp. 1–19, 4 figures). The classification in abstract is as follows:

I. Pacific Province, marked subtropical winter rains, dry or nearly dry summers.
  1. California District, dry summers, infrequent winter snows.
    a. Southern California Region, dry summers 3–4 months long, annual rainfall less than 20 inches.
    b. Central California Region, dry summers 2 months long, annual rainfall 10–30 inches.
    c. Northern California Region, annual rainfall more than 30 inches.
    d. Sierra Region, annual rainfall greater than the central region, much snow.
    e. Tulare Region, annual rainfall less than 10 inches, largest temperature ranges in this district.
  2. Oregonian District, light cyclonic summer rains.
    a. Coast Region, heavy annual rainfall.
    b. Valley Region, least annual rainfall of district.
    c. Cascade Region, intermediate rainfall, more snow than elsewhere in district.

II. Rain Shadow Area, large diurnal and annual ranges of temperature and generally deficient precipitations.
  3. Great Basin District, high maximum temperatures, annual rainfall generally less than 10 inches.
  4. Snake River District, annual rainfall 10–20 inches, sub-Pacific type of distribution.

EFFECT OF CLIMATE ON LOCATION OF MANUFACTURING PLANTS

A PAPER on this subject read by Mr. W. M. Booth at a meeting of the American Institute of Chemical Engineers appears in abstract in the *Scientific American Supplement* for April 3, 1915 (p. 219). The principal manufacturing belt of the United States is located north of the regions where summer heat interferes much with indoor work, and south of the areas blocked by heavy winter snows and hampered by frozen waterways. Within this belt specific climatic conditions may determine the distribution of certain industries. For instance, the manufacture of enameled leather is dependent on sunshine. Atmospheric dryness is an advantage where hygroscopic articles, small steel parts, and other things injured by moisture are manufactured or packed. On the other hand, moist air and equable temperature are desirable for the successful manufacture of linen, cotton, jute and hemp. This accounts for the importance of Fall River, Providence, Lawrence and Lowell as cotton mill centers. Similarly, some of the Pacific Coast cities may become textile centers when labor and markets permit. Adverse climatic conditions may be artificially overcome where other factors make the business sufficiently profitable.

CLIFF DWELLINGS AND CHANGES IN CLIMATE

FROM the abundance of abandoned cliff-dwellings in the Navajo Country of the arid southwest, it might be assumed that there was once a rainfall capable of supporting a popula-

tion much larger than the present. Professor H. E. Gregory at the joint geographical meeting in New York (April 9–10, 1915) has pointed out that the Hopis who built the cliff-dwellings are migratory and frequently abandon a village after having lived in it some years. Therefore, the numerous abandoned villages do not necessarily indicate a larger population and a climate more moist in the later prehistoric times.

THUNDER AND LIGHTNING

DR. WM. SCHMIDT, after many observations with his thunder-recorder, finds[1] that we hear but little of the air vibrations produced by lightning. Thunder is accompanied by irregular pressure changes lasting 1/40 of a second or more and some only 1/75 to 1/120 of a second. The periods of most of the longer pressure waves are 1/10 to 1/3 second—too long for ear perception. Much of the mechanical injury done where lightning strikes is probably due to these waves. From a distance one violent wave comes first, then follow perhaps two or three series of three to four heavy waves each. On account of atmospheric action on irregular waves the thunder becomes of more or less definite pitch. Dr. Schmidt has inferred that at the source the lightning energy may be five million times as great as that of the thunder it produces.

Insurance statistics from both Canada and the United States show the efficacy of lightning rods in keeping buildings from taking fire if they are struck.[2] In Ontario, taking equal numbers of rodded and unrodded farm buildings, twenty times as many of the latter as of the former were struck. In the United States in 1912 and 1913 two hundred insurance companies reported 1,845 buildings struck, of which but 67 were rodded. Considering that 31 per cent. of all buildings insured were rodded, the lightning rod efficiency is thus 93 per cent. Furthermore, the reports of five companies for a period of 13 to 25 years on 18,000 buildings insured, over 50 per cent. being rodded, showed that the average damage of the struck buildings was $10 for the rodded and $2,200 for the unrodded.[3]

According to the best European data, the maximum period for thunderstorms is from 3 to 5 P.M., while the minimum falls just after midnight and from 7 to 8 A.M. The month of greatest frequency is June and those of least are December and January.[4]

Of the 4,520 fires reported on the national forests in 1913, 1,571, or about 35 per cent., were ascribed to lightning.

NOTES

AN unseasonal northeast snowstorm accompanying an intense tropical cyclone visited the Atlantic coast on April 2, 1915. Snow fell from Georgia northward, the heaviest about ten inches being recorded around Raleigh, N. C., at the head of Chesapeake Bay, and on the New England coast. The inland extent was generally less than 200 miles; in the north the railroads reported Utica, N. Y., Woodsville, Vt., and Kineo, Me., as the limits. Raleigh, N. C., seems to have suffered most, being without outside telegraphic communication for five days. In other districts traffic was hampered. The snow melted very rapidly and with little or no runoff, owing to the extremely dry conditions of the soil after an almost rainless March. Thus agriculturally this snowstorm was of great value.

ON May 1 the British Meteorological Office ceased issuing forecasts except to farmers. This was thought necessary because the forecasts might be of value to the Germans.

THE announcement for the 1915 international kite and balloon flights came from the Nicholas Central Observatory at Petrograd instead of from Strassburg as heretofore.

[1] *Monthly Weather Rev.*, December, 1914, pp. 665–671; *Scientific American Supplement*, March 13, 1915, p. 175.

[2] See *Scientific American*, November 28, 1914, p. 347, and April 3, 1915, p. 303.

[3] See also J. Warren Smith, "Efficiency of Lightning Rods," *Ohio Naturalist*, Columbus, O., February, 1915, pp. 437–442.

[4] J. von Hann, "Neue Beitrage zur Kenntnis der taglichen Periode der Gewitter," *Meteorologische Zeitschrift*, February, 1915, pp. 73–82.

Since the closing of the Mount Weather research observatory last winter, the Blue Hill Meteorological Observatory is alone in the United States in regularly flying kites in the international days. However, the Weather Bureau is planning to resume aerological work at Omaha.

A MAP of the eastern United States showing the frequency of dry spells during the last twenty years in the months of April to September inclusive was published in the National Weather and Crop Bulletin, May 4, 1915. The greatest frequency is found in the Great Plains district and the least in the southern Appalachians.

DR. W. KÖPPEN, after study of the monthly period in the weather[6] has come to the conclusion that the moon has no noticeable influence on meteorological phenomena.

A KNIGHTHOOD has been conferred on Dr. W. N. Shaw, director of the British Meteorological Service.

MR. AKSEL S. STEEN, who recently succeeded Dr. Mohn as Director of the Norwegian Meteorological Institution, died in Christiania on May 10.

A NEW departure in the distribution of weather forecasts is announced from Illinois where a newspaper man and the Springfield Watch Co. send out the predictions by wireless telegraph.

CHARLES F. BROOKS

WASHINGTON, D. C.

SPECIAL ARTICLES

ON THE REPRODUCTIVE AND HOST HABITS OF CUTEREBRA AND DERMATOBIA

IN view of the considerable mystery surrounding the host habits of *Dermatobia hominis*, the man-infesting bot of tropical America, now believed to employ bloodsucking mosquitoes of the genus *Janthinosoma* for the carriage of its eggs to the host, the following recently discovered facts relating to the reproductive habit of *Cuterebra* will be of interest, since *Dermatobia* belongs to the same restricted group of flies.

On June 25, 1915, Mr. Raymond C. Shannon, of the Bureau of Entomology, found a female *Cuterebra cuniculi* on the stem of a plant in a low moist spot near a stream in the vicinity of Beltsville, Maryland. The fly was inactive, and had probably recently emerged from the puparium. It was kept alive until July 2, 1915, when it was seen to be growing weak, whereupon it was killed and dissected.

The uterus was found to be of the double-sac incubating type, much after the style of *Sarcophaga*, probably independently developed in the Cuterebidæ and not indicating any close relationship with the Sarcophagidæ. The uterus was estimated to contain well over five thousand eggs and perhaps nearer ten thousand. It is difficult to make a close estimate, as the eggs are disposed in bunches at various angles to each other and the two large sacs which constitute the uterus are irregularly rounded.

The egg is elongate, about 1.75 mm. in length, about .4 mm. in greatest width, gently tapering toward the caudal end, suddenly tapering at the cephalic end, with tough extra-thick and strong reticulated chorion of a deep salmon color, and is furnished with an operculum or lid on one side at the cephalic end. The lid hinges by its cephalic edge, but is easily completely detached. The chorion appeared to be particularly viscid at and near the caudal end. The embryo was undeveloped. The tubular glands are large and evidently functional, and contained a deep rufous-yellow substance. The ovipositor is simple and without any piercing structure.

The presence of the incubating uterus, enveloped with tracheæ, indicates that the egg is held within the fly until the maggot is well formed. The presence of the thick chorion indicates that the maggot is ejected still ensconced within the shell, or that practical oviposition takes place. The simple structure of the ovipositor shows that the egg is not thrust through any integument or surface. Moreover, the fact that the chorion is tough, extra-strong and deeply colored indicates that

[6] Concluded in *Meteorologische Zeitschrift*, April, 1915. Translated in *Monthly Weather Bureau*, April, 1915, pp. 179–181.

the maggot remains quiescent therein exposed to the conditions of the open for more or less time after the act of oviposition. The high viscosity of the caudal end of the chorion indicates that the egg is firmly attached by that end to some surface, where it remains permanently. The high fecundity indicates a high mortality of the first-stage maggot, a reduced chance of reaching the host, and hence presupposes that the egg is not deposited on the host nor on any object that will be certain to come in contact with the host. The operculum at cephalic end indicates that the maggot, on being awakened from its quiescent state, immediately escapes by that exit. A normal excitement of the maggot to activity can be induced only by the heat resulting from close contact with the body of a warm-blooded host animal.

As far as *Cuterebra* is concerned, we can feel quite confident that its host relation is maintained through stealth, and that, barring accidents, the fly never comes in contact with the host. The eggs are probably deposited in the burrows or runways of the rabbits, rats and other small mammals which it parasitizes. I have found these flies in considerable numbers in the southwestern mountain regions of North America, where they uniformly either perch on dead twigs beside a stream or sit on rocks near the running water or on the earth banks of streams. They evidently take such stations in order to observe the movements of rodents, with a view to locating favorable places for oviposition. Their small antennæ indicate a poor sense of smell, while their large and finely-facetted eye-surface indicates good sight.

Dermatobia parasitizes not only man, but many of the larger mammals. Such animals do not live in burrows or frequent regular runways or places of concealment. Thus *Dermatobia* can not hope to reach its hosts by employing the methods of *Cuterebra*. It has a much smaller fecundity, less than eight hundred according to Neiva of Brazil, which indicates that it adopts some method much more apt than that of *Cuterebra* to connect with the host. Its maggots are very common in cattle, dogs and man in South and Central America, yet among the natives no one seems able to identify the fly that deposits the egg. The indigenes of South America accuse a variety of dipterous insects of mothering these maggots.

Within the past decade, observers in Central and South America have discovered a number of instances of mosquitoes, uniformly of the genus *Janthinosoma*, bearing a cluster of *Dermatobia* eggs attached by their ends to the under surface of the body. Apparently the credit for the first discovery of this kind belongs to Mr. F. W. Urich, government entomologist of Trinidad, who sent one of these egg-laden mosquitoes to Washington in 1905. The importance of the matter was not suspected at the time, and the specimen can not now be found. More recently Gonzales-Rincones observed the same thing in Venezuela, and inferred that the eggs were originally deposited on the leaves of plants frequented by the *Janthinosoma*, which gathered them up while walking about. His observations and conclusions were published and endorsed by Surcouf, of Paris.

In the absence of information to the contrary, we are justified in supposing that *Dermatobia* has a reproductive system and egg much on the same practical order as those of *Cuterebra*. Being unable to maintain its host relation in the same manner as *Cuterebra*, and being similarly unable to approach its hosts without unduly alarming them, since both flies are heavy-bodied and noisy in flight, it must necessarily resort to some extraordinary device for accomplishing its purpose.

Judging from the accounts of both natives and foreigners who have been infested with *Dermatobia* maggots, several distinct species of blood-sucking diptera may be employed by the fly for carrying its eggs. Mr. J. C. Crawford, of the U. S. National Museum, during a stay in Costa Rica, was actually bitten by some fly, and a *Dermatobia* maggot resulted at the point of biting. He also relates a case of an American in that country who stated positively that a *yellow* fly annoyed him in numbers on one occasion, crawling beneath his clothing. Afterward some two dozen *Dermatobia* maggots

developed in the region of his chest, where the flies had gained access. This suggests *Chrysops,* the members of which are commonly called deer-flies, and it is extremely likely that this genus may act as egg-carrier for *Dermatobia* quite as frequently as do mosquitoes. It should be stated that the *Dermatobia* flies are not yellow, but of a dark metallic green.

As to the exact modus operandi in the case of *Dermatobia,* it is quite certain that oviposition on foliage is not practised, but that the fly captures the elected carrier and holds it while gluing the eggs firmly by their caudal end to the underside of its body, leaving the cephalic end of the eggs free and in such position that it will come in immediate contact with the skin of any animal bitten by the carrier. Once the carrier alights on a warm-blooded animal, the heat of the latter's body causes the maggot to spring the lid of the chorion and to work its way immediately and doubtlessly very rapidly into the skin, most probably by way of a hair follicle. As suggested by Mr. Crawford, it is practically certain that the empty chorion remains attached to the carrier after the exit of the maggot.

CHARLES H. T. TOWNSEND
U. S. NATIONAL MUSEUM,
July 3, 1915

RAPID METHOD OF COUNTING BACTERIA IN MILK[1]

THE satisfactory control of milk supplies would be facilitated by a rapid method of determining the bacterial content. There can be no question but what the most accurate count is obtained by incubating plate cultures for five days at room temperature, but, in spite of this, two days at 37° C. is the only standard method. This has been adopted because of the urgent demand for a quick answer. Because of the advantage of obtaining results rapidly, the direct microscopical examination of milk is frequently urged. In spite of the obvious weaknesses of this method, such as the errors in measuring the small quantities needed or in centrifuging, and the fact that dead bacteria can not be differentiated from the living, this method has its earnest advocates.

If it were possible to use easily measurable quantities of milk, *i. e.,* from 1/10 to 1 cc., and grow the germs contained therein so that only those capable of forming colonies would be counted, and if this count could be obtained within, say, six hours, the demands in the case would be reasonably met.

If such an accurate count could be obtained in a few hours, it would be possible for the producer or dealer to determine actually the bacterial content of his product before putting it on the market. This would also enable the health official to hold a sample of milk suspected of being beyond the limits permitted until the count could be actually obtained, when the samples in question could be either passed or justly condemned. Under present conditions, when the bacteria are determined by ordinary cultural procedures, such a course is out of the question because it is not possible under any conditions to obtain a count in less than forty-eight hours.

It is possible now to suggest a rapid method, which, I believe, will meet any reasonable demands. The method is a combination of the direct count and the culture methods and is obtained by making small plate cultures on a microscopic slide. These little plates are incubated for several hours (three to six), then the medium is dried down and stained so as to bring out in sharp relief, when examined under the microscope, the minute colonies which have developed.

It is not proposed to go into definite details in this preliminary paper[2] but rather to define the lines along which the investigation is proceeding. In explanation of the methods, however, it may be said that about one tenth of a cubic centimeter of milk is mixed with standard agar and spread over a definite area of a sterile glass slide. When the agar is hard, this little plate culture is put in the incubator for about six hours, under conditions which prevent evaporation. It is then dried, given

[1] Preliminary note. Publication authorized by the Director of the Wisconsin Experiment Station.

[2] An extended account of the method and the results obtained in a series of analyses will soon appear.

a preliminary treatment to prevent the agar from firmly binding the strain, stained, decolorized and cleared. When this dried and stained plate culture is viewed under the microscope, the little colonies are definitely stained and appear highly colored on a colorless or slightly colored background. The colonies appear of considerable size under the low powers of the compound microscope. In fact after four hours of development these colonies are sometimes distinctly visible to the naked eye. Under the oil immersion objective the individual cells are easily seen and the different kinds of bacteria can be separated one from another by the morphology of the cells and their arrangement in the microscopic colonies.

It may be further said that the counts obtained by this method are quite similar to those secured by the ordinary plate method. per c.c. have been examined by both methods. The results obtained indicate that the difference between the counts secured by the rapid method and the ordinary or standard method usually amounts to little more than the variation which occurs between duplicate plates, or between different dilutions in the same analysis by the ordinary plate method.

In the case of recently pasteurized milks or milks with a very low bacterial content, it is necessary to incubate the little plates somewhat longer, *i. e.*, for eight hours.

It seems fair to conclude then that we have here a method which will enable the bacteriologist to obtain a count of the bacteria in milk that corresponds very closely with counts obtained by the standard method in from one eighth to one sixth of the time required by the standard method, and also that the higher the bacterial content, the shorter the time required for the analysis.

W. D. Frost
Department of Bacteriology,
Agricultural Experiment Station,
University of Wisconsin

SOCIETIES AND ACADEMIES

THE NEW ORLEANS ACADEMY OF SCIENCES

The academy met in the Stanley Thomas Hall, Tulane University, on Tuesday, May 18, the final meeting of the year. Miss Edwina Abbott presented a paper on the transfer of mental habits in children. This is the first time in its history of fifty-one years that the academy has been addressed by a woman. Miss Abbott attempted to prove what has been projected as a theory previous to this that one sort of training fits for another, for instance that Greek and Latin train the memory for other things and mathematics trains the reason for other things, or that neatness in one thing tends towards neatness in others. Her tests were made with children who were trained to select pairs of words, not adjacent, on cards and were then taken to a table on which many objects were placed, left there two minutes, then asked to state what objects they had seen. Memory exercises were also given throughout the term. Two sets of children were selected; one was trained, the other untrained. The training was done from November to May. Three tests were made, one in November, one in May and one in between. The trained children improved from 46 to 76 per cent., the untrained from 51 to 71 per cent., a difference of 33⅓ per cent. in favor of the trained children.

Dr. Bean presented two negro brains before the academy to demonstrate differences in the size and shape of the pons and cerebellum. One brain is from a negro man, aged 41, a hyper-onto-morph, small, thin, wiry, with slight muscular development, who weighed about 100 pounds. The other is from a negro man, aged 41, a meso-onto-morph, tall, well developed, well nourished, with great muscular development, who weighed about 200 pounds. The pons and cerebellum of the hyper-onto-morph are small in both antero-posterior and transverse diameters, 25 and 32 millimeters, respectively, but not so flat as in the meso-onto-morph, where the antero-posterior and transverse diameters are large, 29 and 40 millimeters, respectively. This condition is true not only in the two brains presented, but in eighteen other brains so far examined the same relative difference is noted where the types are distinct. Dr. Mann called attention to the difference in size and shape of the convolutions in the cerebellum of the two brains. The meso-onto-morph has more numerous, more complete and smaller convolutions of the cerebellum than the hyper-onto-morph. The brains of the two men weigh the same, hyper-onto-morph 1,417 grams, meso-onto-morph 1,421 grams.

R. S. Cocks

SCIENCE

FRIDAY, AUGUST 27, 1915

CONTENTS

THE TECHNICAL APPLICATION OF MICRO-ORGANISMS TO AGRICULTURE[1]

OUT of a period extending over several centuries, there were developed many scientific and unclassified forces which gradually but with positive progress focused in the person of Pasteur. They were often indefinite, possibly crude, and not infrequently speculative. In the mind of Pasteur they were digested, assimilated, reconstructed and confirmed, reissuing from him in an harmonious whole. When they emerged they possessed tangible form as directive principles founded upon actual demonstration and specific knowledge.

Fermentation, the great fundamental work of Pasteur, came from his hand with new life and singular pertinency. The vitalistic element advanced by him and founded so thoroughly upon experimental data fresh from his efforts became the pilot. While perhaps in error regarding details, the general truths have stood the tests of time. Pasteur's fermentation has put into the hands of every scientist, whether in the field of plants or animals, physics or chemistry, a truly basic working policy. If extended and modified, moreover, it may furnish the most satisfactory theory for explaining the relationship of many microorganisms to disease, not as the only agent, but one of several.

The comprehensive and basic ideas contained in fermentation permeate every province of practical life, and none to a

[1] "The Lower Organisms in Relation to Man's Welfare," Symposium, Soc. of Am. Bact., Sects. C and K, A. A. A. S., Philadelphia, January 1, 1915.

greater extent than the domain of agriculture.

The applications of fermentations may be followed into the management of the soil, the plants which grow therefrom, and the animals which in turn are fed by them. Microorganisms are the initial agents which work through their dynamic forces and contribute the results of their energy to the cause of agriculture and man. More particularly these activities manifest themselves in the upkeep of the soil or in soil fertility with its complications of elemental reactions, in the growth and diseases of plants, in the nutritional and pathological processes of animals, in the canning, drying, refrigerating, brining and spoliation of food, in the production of wine, beer, bread and vinegar, in the care of water supplies, in sewage disposal, in the manufacture of vaccines and serum products, in public health control, all of which make the profession of agriculture more definite and more scientific.

It is peculiarly fitting to assign to Liebig the synthetic initiative in scientific agriculture, for through him agricultural knowledge was first effectively arranged or systematized, brought out of ignorant obscurity, and placed in line for further and secure development. Although he failed to grasp the full significance of the true rôle of microorganisms in nature, he nevertheless provided the encompassing and essential knowledge which enabled microbiology to find the basis upon which to build its superstructure. In other words, he excavated and placed the stone with the cement, but it was left to Pasteur to prepare the framework of the biological building to be placed upon this foundation. Reverting to the forces which focused in Pasteur, Liebig was probably more successful in converging them than any other scientific investigator.

It is especially easy to trace to Liebig's soil studies those pioneer observations bearing on the formation of such compounds as ammonia, and nitrates in the soil, and such other facts as point the way to a utilizable knowledge of scientific agriculture. He recognized the accumulation of nitrogen in the soil, but failed to conceive, before his death, the nature of the process concerned with its accumulation, whether, as we now view it, symbiotic or nonsymbiotic. In advancing the theory that ammonia was washed from the air by the rain, he did not receive general support because it was only a small fraction of the truth. There was lacking apparently a link in the chain of needed evidence. He wandered into the present overwhelming subjects of plant and animal physiology without fully appreciating the labyrinth of scientific dangers and difficulties he was likely to encounter, but he extricated himself with wonderful tact after surveying thoroughly the entrance chambers and the bearings of the leads into the unknown. No one may have brought to light so many experimental data, demonstrated so many isolated agricultural activities as had Liebig, but they were unbounded, to a degree unrelated, and could not be carried fully and successfully to application largely because they lacked the vehicle of a consistent or logical directive principle. In Liebig's day no guiding hand led the way and this wilderness of observation remained dense and impenetrable, for causes and their consequences must include the processes involved, and all must be determined before true, intelligent and continuous progress can be made.

Pasteur, by an almost intuitive insight into the operations of nature, was the first who could with some authority suggest the possibility that nitrification may be instigated by microorganisms. This was later

verified by Schloesing and Müntz, who by inhibiting the function of bacteria by means of an antiseptic found that nitrates failed to be produced, but, without the antiseptic, nitrates formed normally. This was many years before Winogradski isolated the organisms. However, with the finding of the organisms, it became possible to ascertain the conditions under which they operate most energetically, thus establishing control. This resulted, of course, in the addition of intelligent and valuable practises. Recapitulating, therefore, for the purpose of illustrating a single scientific development and sequence over a comparatively short period of time, it may be categorically stated that Liebig recognized nitrification in the soil; Pasteur's mind and hand furnished the general principle, fermentation, and suggested that this change in soil may be due to microorganisms; Schloesing and Müntz demonstrated the truth of Pasteur's suggestion by the use of antiseptics, and Winogradski completed the task by the isolation of the organisms and the study of their nature.

No more interesting scientific fact can be found than the culmination of centuries of observations and speculation in the classical experiments of Hellriegel and Wilfart. The accumulation of nitrogen in the soil had assumed a reality, even in Liebig's time, and the value of legumes to soil fertility was mentioned by Pliny, but it remained for Hellriegel and Wilfart to relate these facts definitely through the microorganisms in the nodules of leguminous roots. Symbiotic fixation of nitrogen materialized. A new era was introduced for practise, since with the isolation of the organisms by Beijerinck two years later it became possible to demonstrate directly the absorption of atmospheric nitrogen by the nodule microorganisms and further to employ them advantageously in the inoculation of plants, until to-day many thousands of cultures are utilized in the course of a year. If our purpose were mercenary, it could easily be calculated that millions of dollars were added to the wealth of the United States without the exhaustion of any resource. Man's power has increased a hundredfold in this particular alone. It may be safely said that it has already measured to this estimate and its possibilities are still open.

Symbiotic fixation of nitrogen must not be confused with the non-symbiotic. As late as 1885 Barthelot determined the presence of microorganisms in the soil which without association or symbiosis with the plant possessed the power of accumulating nitrogen. In the soil this nitrogen appears available for plant nutrition. While this means of gathering nitrogen may appear pregnant with future inducements, as yet its values are illusive, for little headway has been made in transforming the intrinsic energy into forms of great usefulness. This should not, however, be cause for discouragement, for like the discovery of oxygen, its ramifications are its future for man. Projected applications can not be measured by a score of years, but by centuries, not by present attainment, but by future progress.

The activities of microorganisms in the soil do not stop with the decomposition of nitrogenous organic matter resulting through oxidation in nitrification and perhaps later in denitrification or in the symbiotic and non-symbiotic fixation of nitrogen, for with the fermentation of the ternary compounds there are produced such substances as carbon dioxide and other organic acids which act directly or indirectly upon the mineral constituents and in this manner furnish food for plant growth not otherwise available. Then too there are the sulphur and iron bacteria

which have a rôle to play and others doubtless whose work and values we in our ignorance do not recognize.

Soil in the light of microorganisms may be regarded as a substance having for its basis or groundwork mineral constituents of geological origin to which has been added organic matter. Through the fermentations and changes in the organic matter and the solution of mineral substances incited by microorganisms such products are formed which give to plants their existence. The mineral constituents forming the basis must be those, of course, essential to the construction of vegetable tissues, and the organic matter after decomposition such as will contribute required food. The continuity of the supply is paramount. After all the elements are present and the conditions for microbial and plant life provided, the active or operating machinery of the soil is resident in its microorganisms.

It follows also from the above—a matter of great importance to the microbiologist—that soil types are as variable as their geological formations, the mineral constituents which give them their character, and the organic substances which enter into their fertility. This variability is heightened when to it is added a consideration of the varying amounts of mineral and organic substances present. Soil, therefore, as we have employed the term, can not be interpreted from any one type or several types, but rather specific instances and specific types formed under known conditions. Soil, defined by its structural parts, unless concretely and definitely applied to some type, has no existence, but when so defined holds its physical, chemical and biological factors, harmoniously united in its mineral and organic composition.

The dairy as well as soil offers interest to the agricultural microbiologist.

In a sense it is a veritable microbiological laboratory instituted for commercial purposes. On the other hand, to the dairyman it is a great industry based upon several elemental sciences and other distinctive industries. Furthermore, it is concerned with the preparation of milk and milk products for the consumer. Microbiology is only one support in this extensive food manufacture. Our approach is microbiological and our treatment will be its interpretation from this viewpoint, which has been greatly emphasized during the past twenty-five years.

Cow's milk can not receive full approval without the vital and broad question of disease transmission from the animal at once arising. Although knowledge of the importance or extent was at first extremely meager and indefinite, growth has occurred from the time when Klein wrestled with the probabilities of communicating diphtheria through the blood and milk till the present moment which grants specific information and satisfaction in the matter of the most serious diseases. Tuberculosis has assumed huge dimensions within the memory of most of us, for it came into the limelight of popularity by Koch's discovery of tuberculin, a discovery which alone has paid for all the time and means expended upon microbiology since the days of Schwann. As an illustration of doubt and the stage of dilemma and misty ideas necessary to the decisive solution of all weighty questions, the present furnishes the milk producer and microbiologist with the "dairy septic sore throat." These allusions, however, indicate very slightly how great is the "microbiological purity" of milk as it emerges from the cow.

Then as the milk is exposed to the contaminations of the milker, the air, the utensils and the stable, or as it passes through the paths and by-paths of the milking process—the most crucial undertaking

in reality—it becomes more and more laden with dangers. In the eyes of the milk producer the drawing of the milk from the udder and passing it on to the consumer is fraught at times with insurmountable difficulties. This task is not easy for a trained, intelligent manipulator, so many and diverse are the ways of contamination. Too many who have never drawn a drop of milk from a cow under the practical conditions which surround her find it very simple to lay down regulations. To carry these into effectiveness by force against possible negligence, ignorance, indifference and even criminal wilfulness, only increases the strength of the barrier which separates the controlling and controlled elements.

Other important manipulative processes in the dairy as straining, cooling, pasteurizing, cleansing, may be readily designated as a struggle against the army of microorganisms which has been allowed to enter. This warfare is costly when it proves to be nothing more than the undoing of what has been done. It is the recognition of ignorance and conditions over which control is impossible through any plan devised by man, but it is also the award of inheritance and traditions fostered in former generations and neglected as a lowly pursuit.

In the preceding paragraphs artificially reared babes have been the indicators by which the microbial reactions are determined. We now turn to the adult who seeks security from invasions by microorganisms through the medium of milk. The ages have given to us sour cream butter, properly ripened cheese, various palatable fermented milk drinks. Sweet milk is a source of danger, but time has been beneficial in demonstrating that if milk is started with the right fermentation the element of danger is routed. Accordingly, in the knowledge and practises of the day, it is a simple matter to develop innocuous but dominating cultures of lactic or other organisms which will lend themselves to supplanting and controlling those organisms whose presence is not sought in the cream which makes the butter, in the milk which makes the cheese, in the intestines subject to all sorts of defiling and toxic substances, in milk which leads to koumiss, kephir, yoghurt and other delectable milk beverages. The taste once developed, as that which selects a fine wine, attempts to extend the local manufacture and demands for instance for a Camembert or Roquefort a broader field, for in such products are found the bouquet of a *Penicillium* and other organisms which find response even in an American palate.

The vulgar term "starter" exemplifies the Yankee adroitness in the use of words which hit. It must not be gathered that it is confined to the dairy, for it has been used for yeast in the making of bread, in brewing and wine production, in vinegar manufacture, and elsewhere. The new method employs a starter which is a known culture of microorganisms and the old method employed a starter, under different names, of unknown germ content.

Not only milk, but foods of many kinds command the attention of the microbiologist, and they all in some form concern the farmer. Whether in preservation by drying, by heating, by refrigerating or by brining and the use of preservatives; whether in fermentation leading to some useful end; whether in putrefaction or decomposition resulting in the destruction of the food with or without the production of toxic substances; or whether in those abnormal conditions instigated by disease-producing organisms calling for inspection or public control, microbial processes are involved and microorganisms, the active

agents which are to be fostered or hindered, constitute the pulsating center of effort.

The drying of some foods has been practised haphazardly since very ancient times; the value of heat has long been known to check the advance of decomposition, even long before Spallanzani in about 1770 gave to the world his experiments with the preservation of vegetable and meat infusions; King Solomon kept snow in trenches covered with bushes and leaves through the summer, that he might have it to cool his drinks; the use of chemical substances whether for physical or toxic purposes appears to be of more recent origin. Even though observation had divined relationships and established limited and crude practises, it is a simple truth that the food industries founded upon desiccation, heat, cold and chemical compounds made no headway of significance until it was found that underlying them was the directing general principle: Food would spoil if the microorganisms were allowed to develop; if they were not allowed to develop it would remain practically unchanged. As soon as Brieger was able to point out some of the toxic substances which microbial life produced, this same principle was extended to poisoning of food undergoing decomposition. It was not, however, until the relationship of microorganisms to disease was established that inspection became truly effective, notwithstanding it had been in operation from Biblical times in much the same way as the preservation of food was practised.

I ask you to consider for a moment what economic import is contained in the preceding paragraph. Conceive if you can the amount of dried food, the number of canned containers, the food consumed which has been in cold storage or refrigeration, the value of the preserved or brined products for which you as an individual are responsible during the course of the year; you will then not be surprised at the quantities necessary to stock for one trip a great ship which carries five thousand persons. Multiplying the individual capacity by 100,000,000, our country's capacity is ascertained. What does this mean in terms of the industries indicated? To this add the great reduction in the number of cases of food poisoning together with the elimination of diseases by meat inspection; then may I again ask, is it possible to grasp the full force of what has been evolved by an acquaintance with the forms, functionings and habitats of microorganisms?

It is with peculiar pride that, in passing on to other matters of weight to both microbiology and agriculture I can, incidentally, pay tribute to Professor Burrill, the venerable worker who named the cause of pear blight as early as 1883 when he had no trail to follow; and to Erwin F. Smith, who has contributed so much to the study of bacterial diseases of plants through discoveries and the organization of knowledge in this field even in the face of much German antagonism and criticism. Our national spirit may be pardoned for the moment, while realizing that there are no international boundaries for science. From this work effective methods of control have been formulated and have enabled intelligent handling of such diseases by those concerned.

No province of microbiology even from the very beginnings of this branch of science and also back through its speculative stages of development, has received greater attention or enrolled a larger army of investigators or given more important results than that which is commonly designated as medical, sanitary or hygienic. Its gifts are broader than any industry, greater than those of any profession, and they can be measured only by the limita-

tions of humanity. While pertinent to every aspect of urban life, they are equally valuable to him who finds his work in the country.

Pasteur's mind touched economic problems. As soon as he conceived a problem he projected it to its applications. Fermentation was interesting to him not only as a scientific problem, but because heavy losses were incurred every year from improper management. He was assigned by Dumas to the study of the silkworm disease, conquered it, eliminated it, and made it possible for the silk industry to succeed. He attacked anthrax because it was making ravages among the live stock of France. By his methods of vaccination he was able to control it. He became interested in rabies and in this his unique work developed a treatment which has proved successful. This taken in connection with the introduction of Lister's aseptic and antiseptic surgery unlocked the door to an exceedingly wide field of application. To comprehend it (even by one fairly familiar with it) presupposes human power in excess of that which really exists, for it implies a knowledge of nearly every walk in life. It reaches every point touched by the human hand. In the early eighties many diseases were traced to their origin, the organisms isolated and studied in the light of prophylaxis. Then infectious diseases were a nightmare; to-day we feel they are under control and we rest in the contentment of a victory. Through the labors of the workers beginning with Pasteur followed by Lister, Koch and scores of other notable investigators, the profession of medicine has grown out of its ignorant mysticism into a science; veterinary medicine has found its inspiration, and public health has become a tangible reality.

Of the total number of infectious diseases, those attacking animals form no small part. The economic importance in this respect affects not only the producer, but the consumer as well. Here as in human medicine progress is making. With the later development of serum-therapy as in the case of hog cholera, of vaccines as in the case of black leg and other diseases, there promises to be eventually a time when most of the animal infectious diseases can be either cured or prevented.

We must not forget either that we still have not extended to our rural communities the full meaning of water supply control so satisfactorily operating in cities and towns. There are those who tell us that typhoid fever is a rural disease. This can easily be understood when the conditions generally existing are known. Water supply on the farm concerns not only the farm home and the farm animals, but by its issuing from the farm through the channel of milk, the city home as well. Before improvement is assured, the farm home must adopt safe methods of sewage disposal which are open to it. With the development of these resources; with the accumulation of rural wealth; with the formation of tastes with tone, the benefits now enjoyed by urbanites must extend to the country and carry with them the sanitary and health lessons associated with a knowledge of organisms.

It is easily surmised from the foregoing that only some of the most important microbiological features of agriculture have been treated, and these subjects in a very cursory manner. Furthermore, there is evident in all assertions an attempt to depict a general agricultural development in the light of the development of a single branch of science. Lest I may conclude the paper leaving a false impression behind, I ask your forbearance while I utter a word of explanation. Agriculture is a vast and composite division made up of

many industries, founded upon many elemental scientific pursuits. Science in reality can not be divided and subdivided, but is intricately and firmly bound together so closely that one branch can not develop fully without the other. Accordingly, to grasp a truthful and comprehensive notion, the industrial and scientific growth in agriculture should be measured only through all branches of science concerned, all practises involved, and the various industries included. It is this sort of concept of science in agriculture I ask you, in my closing sentence, to seek; and not simply a view which results from a study of a component of the whole.

Charles E. Marshall
Massachusetts Agricultural College,
Amherst

AN ANALYSIS OF THE MEDICAL GROUP IN CATTELL'S THOUSAND LEADING MEN OF SCIENCE

The basis of the present study is the list of starred names in the 1906 and 1910 editions of Cattell's "American Men of Science" representing individuals who are engaged in teaching or research in medicine or who, though occupying other fields, are directly or indirectly advancing knowledge in the medical sciences.

The analyses, presented for the most part in tabular form, have been made with the object of determining

1. The principal field of activity of each individual.
2. The overlapping of different fields of activity.
3. Nativity.
4. Age.
5. Sex.
6. Education as represented by degrees.
7. Education as represented by institutions.
8. Post-graduate study.
9. Service in one or more institutions.
10. Present distribution with rank.
11. Lapse of time between degree and full professorship.
12. Change of field of activity.
13. The clinician's position as an investigator.

It is true that the entire number of individuals is too small to allow far-reaching conclusions to be drawn. Medicine in this country is, however, undergoing so many changes—changes which began about twenty-five years ago and will doubtless continue—that it seemed advisable to analyze, for future students of medical education and medical progress, the conditions as represented in Cattell's editions of 1906 and 1910. The trend of these changes and the influence of the development of the medical sciences can be traced even in the first edition and markedly in the second, by separating the older group of men, limited to chemistry, anatomy, physiology and pathology from the younger group representing, in addition to these, bacteriology, physiological chemistry and pharmacology. In the absence, however, of definite tables of earlier periods, it is difficult to draw comparison from the first edition, except such as are possible on the basis of age. If one had tables for, say 1890 to 1895, the period representing the beginning of the rapid development of the laboratory side of medicine in this country, the analysis of 1906 and 1910 would be of greater value. Still, it is hoped that the present study will preclude such regrets on the part of some student of medical education who wishes in 1930 to analyze the advances during the period of twenty years preceding his study.

The basis upon which Cattell selected the names for "American Men of Science," as well as his method of selecting the thousand leading men, are too well known for repetition. It must suffice to state that in the first edition are the records of 4,000 men and women and that the second edition was enlarged to include 5,536. The directory is essentially a list, with short records, of individuals working in the natural and exact sciences, and it is presented as "a fairly complete survey of the scientific activity of a country at a given period." Cattell's object in preparing the special list of a thousand leading men was to secure a group for the scientific study of the "conditions on which scientific research depends and so far as

may be to improve these conditions." One other point is of importance: although the first edition was published in 1906, the record apparently was completed before January 1, 1903,[1] and the first edition therefore refers to conditions as of the latter year. For this reason the list prepared from the first edition will hereafter be referred to as the "1903 list" and that of the second edition as the "1910 list."

To my use of Cattell's list of a thousand leading men as a basis for the selection of a medical group, there can be, I think, no objection. The group of medical names is all inclusive and represents medical men of every degree of scientific effort. Moreover, as a result of my studies of the special group of 238 names, I consider the selection well made; I have found only two names without stars, that in my opinion should have been starred and, on the other hand, only three starred that perhaps did not deserve a star.

METHODS OF SELECTING THE MEDICAL GROUP

In Cattell's "thousand men" those representing the medical sciences doubtless fall in the four groups: chemistry, 175; pathology, 60; physiology, 40; and anatomy, 20.[2] The three last groups are probably almost entirely composed of men working in the medical sciences, while of the first group relatively few are interested in medicine. In my classification which gives 179 names in the 1903 list and 59 new names in the 1910 list, I have disregarded Cattell's groupings for the reason that I desired to obtain a list representing men who are advancing a knowledge of the medical sciences without regard to their relation to medical schools. Thus embryologists, comparative anatomists, chemists and biologists, whose researches bear on medical problems or contribute to the methods of the medical sciences, have been included. The list is one of men working in the sciences bearing directly upon medicine rather than of medical men concerned with science.

[1] See second edition, pp. 531 and 538.

[2] The other divisions are: physics, 150; zoology, 150; botany, 100; geology, 100; mathematics, 80; astronomy, 50; psychology, 50; anthropology, 20.

Some of the criteria upon which the selection of names was made follow: A person engaged in teaching and research in medicine, whether or not possessing the M.D. degree is, of course, included. The possession of the M.D. degree by a person not concerned with medical teaching or research is not sufficient reason for inclusion unless this person's work has some bearing on medicine; thus a zoologist or biologist with the M.D. degree is not included unless he has been concerned with studies in neurology, embryology or comparative anatomy. On the other hand, a biologist without the degree of M.D., but contributing to the knowledge of the anatomy or embryology of mammals is always included as one concerned in advancing the knowledge of the medical sciences. Despite these rules, the decision as regards zoologists and biologists has sometimes been difficult, but has always rested on the relation of research work to medicine. A like difficulty arises in regard to chemistry, especially among the older group representing chemistry before the rise of physiological chemistry. Naturally a chemist whose life work has been the teaching of medical students is included irrespective of work in other fields; on the other hand, an individual holding a chair in general chemistry and teaching medical students only incidentally, and whose investigations have nothing to do with physiological chemistry is not included. So also are judged a few workers in industrial or agricultural chemistry; if their work has a direct bearing on normal physiology or the problems of disease, they are included; otherwise not. Thus chemists concerned with the study of metabolism in man or animals, but without medical degree or affiliation with medical schools, are included, as are also chemists whose problems are those of sanitation and public health closely related to the problems of the acute infectious diseases; on the other hand, sanitary engineers, concerned with water filters, sewage problems, etc., are not. The same holds for bacteriologists; a bacteriologist of non-medical training or affiliation, studying diseases of animals is accepted; one engaged only in the systematic study of lower plant

forms, or the diseases of plants is not. Psychology offers some difficulties. All workers in psychology may be indirectly contributing to the knowledge of normal and abnormal mental conditions, but the line has been drawn so as to include only those who use the material afforded by the insane and feeble-minded; that is, those who have entered or are closely in touch with the field of psychiatry; or, on the other hand, are responsible for the teaching of medical students. Pharmacists, pharmaceutical chemists and botanists interested in materia medica, although the group is very small, have caused some difficulty. They have been classified, in part, on the basis of the character of their researches, and in part on their medical affiliations, as either chemists or pharmacologists.

Under physiologists, plant physiologists have not been included, unless their work has a bearing on pharmacology; all, however, who work on lower animal forms and offer knowledge of importance to the understanding of mammalian physiology have been included.

In two small groups another factor enters; a few individuals have reached a position of importance, in fields distantly related to medicine, but owe their success in part, at least, to early efforts in clinical medicine or the medical sciences; on the other hand, a few men occupy fields which a few years ago had no relation to medicine but which now are of importance in the border-line problems of the medical sciences. In each group the decision has been laid upon the individual's influence upon medical teaching and research.

CLASSIFICATION

My classification of the medical group is made according to the predominant interest of the individual. In Cattell's classification all medical effort is distributed under the four important headings of anatomy, physiology, chemistry and pathology, with a possible scattering of medical effort under zoology, psychology, etc. To bring in the various distinct subdivisions of medicine and its allied sciences, and to give a true picture of the activities of the starred men of the medical or near-medical group, it has been necessary for me to classify under eleven headings (see Table I.). This has been necessary because a considerable number of individuals classified in Table I. as anatomists (including histologists and embryologists) are classified in "American Men of Science" as zoologists, biologists, etc. As, however, they are from the medical point of view, and for the purpose of this study, anatomists, they are so grouped. So also in the case of physiologists, pharmacologists and chemists, who may have interests in two or three fields, each individual is grouped in the field in which he has shown the greatest activity, despite the fact that according to this rule a professor of physiology may be classed as a physiological chemist. The same rule holds for those grouped by Cattell under bacteriology and hygiene, or under pathology and medicine, etc. Another difficulty arises in the group engaged in the practise of clinical medicine; an individual may be classed in "American Men of Science" under "Medicine, Neurology," or "Pathology, Medicine," though in each case neurology or medicine is the principal field of effort of the individual. Under such circumstances, provided the individual is actually engaged in clinical work, he is given a clinical classification. In some instances this robs the laboratory branches of one or two men, but, as a rule, it is merely a matter of transferring a name from "Medicine" to Surgery, Pediatrics or Psychiatry, as the case may be, and takes out of the group "Pathology," a number of clinicians who are pathologists only in the sense that they are diagnosticians of disease. Likewise the free use, by Cattell, of the single designation "Medicine" in the case of a surgeon or a psychiatrist, has necessitated the addition of other fields, as surgery, psychiatry, pediatrics, etc. In all this revision of classification the personal opinion of the writer, based on a knowledge of the work of the individuals concerned, is the chief factor. That this personal element may have led to occasional errors is possible; but for the purpose of distinguishing between the different types of activity, it is believed to be without essential error.

Whenever possible the analysis of the lists

of 1903 and 1910 is shown as a distinct part of one table. When, however, this would entail a large awkward table, and when there is no particular advantage to be gained, a composite table is given. Occasionally where differences are striking the two lists are presented in separate tables.

In interpreting these tables it should be borne in mind that although with each new edition Cattell prepares a new list of one thousand leading scientists, the names starred in an earlier list are still retained unless dropped by reason of death or removal to a foreign country. Thus in the 1910 edition of "American Men of Science" more than a thousand names are starred. The exact number over a thousand is the difference between the new names added and those dropped on account of death or departure from the United States. Therefore, my list of 59 names, taken from the second edition, includes names not starred in the 1906 edition and, naturally, none of the names which at that time were starred, with one exception, a person who changed from work in general biology to distinctly medical research. The losses of starred names in 1910, as compared with 1906, were six in number: by death, Wilbur Olin Atwater (physiological chemistry); James Carroll (bacteriology and pathology); Gaylord Parsons Clark (physiology), and John Bruce MacCallum (anatomy and physiology); by removal from the country, Arthur Robertson Cushny (pharmacology), and William Osler (medicine). (The name of Ira van Giesen appears in the first edition but not in the second and is not noted among deaths or removals.)

It should also be explained that although the directory includes many Canadian scientists, these are not considered by Cattell in making up the lists of 1,000 leading men.

A classification, according to principal field of activity, is shown in Table I.

Despite the attention given to classification, as described above, certain liberties have been taken with this table; under pathology (comparative) has been included an individual classified by Cattell as a medical zoologist; under bacteriology are included three individuals whose chief work is in hygiene; and under pharmacology are included two men who are essentially medical botanists. These inclusions are made here for the sake of shortening the table; in later tables, however, due allowance has been made so that statistics concerning pharmacologists, for example, are not confused by including botanists. It should also be stated that under neurologists are included only men working in clinical neurology or neuropathology. Neurologists, in the sense of anatomists studying the anatomy of the nervous system, and not in clinical work, are included under anatomists.

The chief points of interest brought out by this table are: (1) the large number of individuals in the older laboratory sciences—anatomy, physiology and chemistry—as compared with the number in those, pathology, bacteriology and pharmacology, of more recent development, and (2) the relatively small number of clinicians who have attained scientific distinction. These differences hold in both lists.

TABLE I

Classification According to Principal Field of Effort

Field	1903 List Number		1910 List Number
Anatomy.....	45	Including histology, embryology and comparative anatomy..................	12
Physiology....	31	Including comparative physiology..................	11
Pathology.....	21	Including comparative and experimental pathology......	6
Bacteriology...	15	Including protozoology and hygiene..................	7
Chemistry....	29	Inorganic, organic, physiological pharmaceutical and micro-chemistry and toxicology..................	9
Pharmacology.	7	Including materia medica, therapeutics and medical botany..................	4
Medicine.....	20	Refers to internal medicine...	2
Psychiatry....	3	Including psychology........	8
Neurology....	3	....	2
Surgery.......	2	....	3
Pediatrics.....	3	....	0
	179		59

Total of both lists, 238.

TABLE II

Laboratory Group, Showing Overlapping of Fields of Activity

	1903 List	1910 List
Anatomy and zoology	9	1
Anatomy and biology	5	2
Anatomy and physiology	5	0
Anatomy and neurology[3]	3	0
Anatomy, neurology[3] and biology	1	0
Anatomy, biology and physiology	2	0
Anatomy, biology, zoology, neurology[3] and physiology	4	0
Anatomy, anthropology and neurology[3].	1	0
Anatomy, biology and zoology	2	0
Anatomy, pathology and bacteriology	2	0
Physiology and hygiene	1	0
Physiology and history of medicine	1	0
Physiology and psychology	2	0
Physiology and biology	3	1
Physiology and neurology[3]	1	0
Physiology and pharmacology	4	1
Physiology and physiological chemistry.	8	0
Physiology and pharmacology and physiological chemistry	2	2
Pharmacology and physiological chemistry	2	2
Pathology and physiological chemistry.	0	2
Pathology and bacteriology	13	4
Pathology and bacteriology and hygiene	2	0
Pathology, physiology and experimental surgery	0	1
Bacteriology and hygiene	4	4
Bacteriology and biology	1	0
Bacteriology and zoology	1	0
Bacteriology, hygiene, biology and physiological chemistry	2	0
Bacteriology, hygiene and physiological chemistry	1	1
Chemistry and hygiene	1	0
Chemistry and toxicology	3	0
Chemistry and pharmacy	2	1
Chemistry and hygiene	2	0
Chemistry and physics	1	0
Botany, pharmacy and materia medica.	2	0
	93	22

In connection with the clinical branches, the striking fact is shown that in the 1903 list more men have gained scientific distinction in internal medicine than in all the other fields of clinical effort combined. On the other hand, in the 1910 list, the distribution is more even. The preponderance of internists in the earlier list is due, as will be shown later, to the large number of teachers of medicine, who before the period of laboratory expansion combined with their teaching, investigations in pathology, pharmacology, hygiene, etc.

[3] Refers here to anatomy or physiology of the nervous system; not to clinical neurology.

TABLE III

Clinical Group—Variety of Interests

	1903 List	1910 List
Medicine and anatomy	1	0
Surgery, anatomy, physiology and materia medica	1	0
Medicine and physiology	1	0
Surgery, neurology[4] and physiology	1	0
Surgery and physiology	0	1
Neurology and physiology	1	0
Medicine, pathology, pharmacology and physiological chemistry	1	0
Medicine, pathology and therapeutics	0	1
Medicine, pathology and physiology	1	0
Medicine, neurology, physiology and toxicology	1	0
Medicine, neurology and psychiatry	0	1
Medicine, pharmacy and materia medica.	1	0
Medicine and physiology	1	0
Medicine and pathology	6	1
Medicine and hygiene	0	1
Medicine, pathology and bacteriology.	2	0
Medicine, pathology, bacteriology and hygiene	1	0
Medicine, pathology and physiological chemistry	1	0
Medicine and physiological chemistry	0	1
Obstetrics, pathology and bacteriology.	1	0
Neurology, psychiatry and pathology	1	1
Medicine, bacteriology, hygiene and bibliography	1	0
Botany, physiology, materia medica, pharmacology, medicine and neurology.	1	0
Psychiatry and hospital organization	1	0
	25	7

Although Table I. shows the general distribution by important groups, it does not give a complete picture of the variety of effort represented by some of the members of these

[4] In this table neurology refers to clinical neurology.

groups. In Tables II. and III. this variety of effort is shown. Incidental effort in a neighboring field is not indicated, only more serious effort in teaching or research. Table II. represents laboratory effort only, while Table III. shows the activities of those persons engaged in the several fields of clinical medicine.

Thus it is seen that of the 179 individuals in the 1903 list 118 or 65 per cent. were interested in more than one field of activity; while in the 1910 list only 49 per cent. were working in more than one field. These figures would appear to indicate, among the latter group, a tendency to specialize.

NATIVITY

Table IV.[5] shows distribution according to birth. For the purpose of condensing the table no state is given alone unless it is represented by more than two names; states with one or two names are grouped under the words "other states" appearing in each division. For the sake of record these may be given as follows: Vermont 1 (1903); New Hampshire 1 (1910); District of Columbia 1 (1903); North and South Carolina each 2 in 1903; Tennessee 2, Alabama and Mississippi each 1 in 1910; Minnesota 1, in 1903; Colorado and California each 1 in 1903, and California 1 in 1910.

TABLE IV

Nativity: Born in United States, 200. Foreign Born 37[6]

	North Atlantic Division							South Atlantic Division			South Central Division		North Central Division								Western Division	Foreign Born							
Lists	Maine	Massachusetts	Connecticut	New York	New Jersey	Pennsylvania	Other States	Maryland	Virginia	Other States	Kentucky	Other States	Ohio	Indiana	Illinois	Michigan	Wisconsin	Iowa	Missouri	Other States	All States	Canada	British Isles	Germany, Austria	Sweden	Switzerland	Russia	India	Japan
1903	5	22	9	31	5	17	1	9	5	5	3	0	10	4	5	5	8	3	1	1	2	13	6	5	0	1	2	1	0
1910	1	6	1	9	2	2	1	1	3	0	2	4	5	3	1	1	1	1	4	0	1	1	2	2	2	0	1	0	1
Totals	6	28	10	40	7	19	2	10	8	5	5	4	15	7	6	6	9	4	5	1	3	14	8	7	2		3	1	1

If this table is contrasted with a similar table by Cattell in which is analyzed the larger group of one thousand scientists, the following points of similarity or difference appear:

1. Of the larger group (1,000) 126 were foreign born; of the medical group (238), 37; 12.6 per cent. as compared to 15.5 per cent. Of the 37 foreign born, 14 were natives of Canada, and if these are set in a separate group, the members of the medical group of non-American birth are but 9.6 per cent. Another point is of interest in this connection: In our 1903 list, 13 medical men are shown to be of Canadian birth, while Cattell's corresponding list shows for the entire 1,000, a total of 34 of Canadian birth. This shows that more than one third of the individuals of Canadian birth have achieved their prominence through the medical sciences. As far as any one influence is concerned in this it would appear to be connected with the University of Toronto. Of the 13 individuals of the medical group, resident in the United States in 1903, eight were graduates in arts or medicine of this university. No other Canadian institution is represented by more than one individual. On the other hand, as five of the Canadians went to Hopkins for post-graduate study, this institution would appear to be a secondary important factor in that it drew the

[5] In this and all other tables in which totals do not agree with those of Table I., it is to be understood that the records, as given in "American Men of Science," were, in some instances, incomplete or difficult of interpretation.

[6] Birth place of one individual in 1903 list not given.

men from Canada. Only two other institutions, Clark and Chicago, attracted two men each. This Canadian influence is lost, however, in the 1910 group, which contains only one individual born in Canada.

In connection with the group of 37 foreign born, it is of interest that nearly one half received part or all of their education in the United States, thus five received the Ph.D., eight the M.D., and four the bachelor, and later degrees from American schools. On the other hand, twenty appear to have finished their professional education in other countries. On the basis of this analysis it would appear, therefore, that only 8.4 per cent. of the entire medical group of 238 individuals represents entirely foreign educational influences.

It is of interest that the distribution by birth in this country of the medical group is in general in proportion to Cattell's figures for the larger group of one thousand men of science. This is shown in the following table in which only those states are given which have 20 or more men in the 1,000 list.

TABLE V

Nativity: Comparison of 1,000 with Medical Group

	N. Y.	Mass.	Ohio	Penna.	Ill.	Conn.	Wis.	Maine	N. J.	Ind.	Mich.	Md.	Iowa
Cattell's 1,000	183	134	75	66	42	40	35	29	28	28	27	26	20
Medical 238	40	28	15	19	6	10	9	6	7	7	6	10	4

AGE

Table VI. gives the age by decades of the individuals composing the various subdivisions of the medical group, as prepared from the 1903 list. To this is added the analysis, by age only, of members of the 1910 group. This table presents several points of interest. In each list the decade represented by the largest number of individuals is the fourth; in the 1910 list, the majority of all names falls in this decade, while in the 1903 list it is shared by the fourth and the fifth decades. As, however, we have no lists before 1903, for comparison it is impossible to say how many of the men in the fifth decade, in 1903, might have been starred in a list prepared in 1893, when they were between 30 and 40. All evidence points to the fourth decade as the period when the majority of men in the medical sciences reach an unusual degree of prominence. From the 1910 list it is certain that the chance for prominence diminishes rapidly after the 40th year. This may not be true in clinical medicine, for, as shown in the 1903 list, the largest number appear in the fifth and seventh decades. The various laboratory specialties show little difference except in the case of anatomy and pathology, each of which has an unusual proportion of individuals reaching prominence in the fourth decade. In these two branches half the total number in each group fall in the fourth decade. The probable explanation lies in the changes in medical education which began in the early nineties. Until that time pathology was in most schools taught by a clinician and the teaching of anatomy was *frequently relegated to a* surgeon. The divorcing of anatomy and pathology from medicine and surgery and the increase of laboratory teaching in these two subjects opened many opportunities for scientific work, previously closed. These changes, in all probability, explain the large number of prominent men in these two fields who in 1903 fell in the fourth decade.

TABLE VI

Age

1903 List	20–30	30–40	40–50	50–60	60–70	70–80	Age Not Given
Anatomy	3	22	13	5	2		
Physiology	4	10	11	5	1		
Chemistry		10	9	7	2	1	
Pathology	1	10	7	2			1
Bacteriology and hygiene	1	4	6	1	2		1
Pharmacology, therapeutics		2	5				
Medicine		4	6	3	6	1	
Surgery, neurology, psychiatry, pediatrics		3	2	3	2	1	
Totals	9	65	59	26	15	3	2
1910 list—totals	1	34	14	9	1	0	
Combined totals	10	99	73	35	16	3	2

SEX

In the 1903 list of 179 names, 4 women find a place, three representing anatomy and one

hygiene; in the 1910 list, three are added, two representing anatomy and one bacteriology and chemistry; a total of 7 or almost 3 per cent. of the combined lists.

EDUCATION AS REPRESENTED BY DEGREES

In connection with Table VII., which presents the educational qualifications of the members of the medical group, as shown by their degrees, a few words of explanation are necessary. Honorary degrees are not included. M.B. is given the same value as M.D. The omissions tabulated under "insufficient data" refer to an anatomist who is described merely as a "licentiate," one chemist with the single degree of E.M.; and to a third individual whose record gives no information concerning degrees. Otherwise degrees are accurately given, except that the chemist with bachelor's degree only should be credited also with a degree in pharmacy (Ph.G.). In the column headed "M.D. only" the figures in brackets refer to the number in this class who took some academic work but did not receive the bachelor's degree.

The figures for the 1910 list are given at the bottom of the table without division into scientific groups.

The figures presented in Table VII. bring out some interesting facts. The most striking of these is the small number of men in the 1910 list with the degree M.D. only, 8.5 per cent. as compared with 24.5 per cent. in the 1903 list. That this is not due to a larger number of men with the Ph.D. degree only, is shown by the fact that in the two lists the percentage of individuals[7] with the latter degree only, is practically the same, 26.2 per cent. for 1903 and 25.4 per cent. for 1910. On the other hand, the number of individuals with M.D. degree equals 68 per cent. in the 1903 lists and 71 per cent. in the 1910 list, again practically no change. The conclusion is unavoidable that about two thirds of the prominent men in each list were developed through the training represented by the M.D. degree and about one quarter through that represented by the Ph.D. degree, but that in the period represented by the 1910 list, there was a greater tendency on the part of the M.D. group to anticipate the present educational prerequisite in medicine—a collegiate education. In the 1903 list individuals with the bachelor's or master's degree antedating their M.D. degree constitute only 34 per cent. of the total; in 1910 this percentage increased to 51. On the other hand, it is worthy of note that in the entire list of 238 individuals only 9 achieved distinction on the basis of the bachelor's or master's degree or the degree Sc.D.

TABLE VII

Education as Represented by Degrees—238 individuals

1903 List	Bachelor's and M.D.	Master's and M.D.	Bachelor's Sc.D. and M.D.	Ph.D. and M.D.	M.D. Only	Bachelor's Only	Bachelor's and Master's	Bachelor's and Sc.D.	Ph.D.	Bachelor's Sc.D. and D.V.M.	Sc.D. and M.D.	Insufficient Data	Totals
Anatomy	9	6	1	1	10 (3)	1	1	1	14			1	45
Physiology	4	6		3	6 (3)				11	1			31
Chemistry	2	1		3	2	1	1	1	15		1	1	29
Pathology	7	4		2	7 (5)				1			1	21
Bacteriology and hygiene	1		1	1	6 (2)		1		5				15
Pharmacology	2	1		2	2 (1)								7
Medicine	8	2		1	9 (1)								20
Surgery, neurology, psychiatry, pediatrics	4	4			2 (2)				1				11
Totals	37	24	2	13	44 (17)	2	3	2	47	1	1	3	179
1910 list	19	11	1	6	5	1	0	1	15	0	0	0	59
Combined totals	56	35	3	19	49	3	3	3	62	1	1	3	238

[7] In this calculation individuals with both M.D. and Ph.D. degrees (13 in 1903 and 6 in 1910) are classed in the M.D. group, as is also one individual with ScD. and D.V.M. degrees.

With the exception of the Ph.D. degree, the various degrees are distributed about equally among the several medical sciences. Anatomy, physiology and chemistry, the older and more exact of the group, claim, as would be expected, nearly all the Ph.D. men.

EDUCATION AS REPRESENTED BY INSTITUTIONS

In Table VIII. is presented the group of institutions which have given five or more degrees to individuals in 1903 and 1910 lists. In this table degrees are tabulated, not individuals, that is, a man receiving the degrees A.B., A.M. and M.D. is tabulated three times; if, in addition, he received a Ph.D. degree, he receives four places.[8] The object of the table is to show in a general way the institutions concerned in training the larger number of the group. To limit the tabulation to institutions granting five or more degrees is not entirely satisfactory, but the list of institutions

TABLE VIII

Institutions Represented by Five or More Degrees; 1903 and 1910 Lists Combined

	A.B.	B.S.	Ph.B.	A.M.	M.S.	Sc.D.	Ph.D.	M.D.[9]	D.V.M.	E.M.	Ph.G.	Totals
Harvard	22	7		15		3	5	24				76
Johns Hopkins	13	1			1		18	14				47
Columbia	4		2	4			7	18		1		36
Yale	8	5	3				8	3				27
Pennsylvania	4	2	1				2	18				27
Michigan		5	1	1	3	1	2	8				21
Chicago (including Rush Med. School)		2			1		13	5				21
Cornell	1	3	3	1		1	1		1			11
Toronto	7			1				2				10
Princeton	4			4								8
New York University and Bellevue								6				6
Leipzig							4	2				6
Wisconsin		3			1						1	5
Missouri		2						3				5
Northwestern		1			1			3				5
Amherst	4			1								5

credited with four, three, two and one degree is so lengthy that tabulation is impossible. Thus three institutions are credited with four degrees; six with three; seventeen with two and one hundred and sixteen with one. The tabulation of these in detail serves no good purpose. If we compare Table VIII. with Table VII. we find in regard to the M.D. degree that 106 of the 163 medical degrees were given by 12 institutions; the remaining 57 being scattered among 35 institutions. Also 60 of the 81 Ph.D. degrees were granted by 9 institutions; the remainder representing 13 institutions. 21[10] of the M.D. and 15 of the Ph.D. degrees were granted by foreign universities. Foreign universities giving more than one M.D. degree are Toronto, Strassburg, Bonn, Leipzig, Aberdeen and Edinburgh. The only foreign universities which find a place in the table are Toronto and Leipzig.

Some objection might be raised to the insertion in this table of Amherst and Princeton, which do not have medical departments. However, the table is intended to represent general educational preparation and brings out prominently the important rôle played by Harvard, Hopkins, Columbia, Yale, Pennsylvania, Michigan and Chicago—the universities represented by more than twenty degrees—in the development of the medical sciences.

One or two minor points noted in the preparation of this table are:

1. The women's colleges represented are Smith, Radcliffe, Vassar and Bryn Mawr.

2. The figures for Toronto, Amherst and Northwestern are based on the 1903 list; no new names occurred in the 1910 list.

3. Homeopathic schools are represented by two individuals, one working in botany and materia medica and the other in anatomy and anthropology.

One purpose in preparing Table VIII. was to determine how many men took all their work in one university and whether workers in any one scientific group favored certain universities. The analysis on this point yields the following information: Of 62 individuals with the Ph.D. degree (in 1903 and 1910 lists) 24 took all work leading to this degree in one institution, as follows; Johns Hopkins: anato-

[8] There is in this table a slight error due to the fact that Ph.D. men do not always give data concerning the bachelor and master's degree.

[9] Including M.B.

[10] Of these 5 were conferred by Canadian; 4 by English, and 12 by German schools.

mists, 2; physiologists, 4; physiological chemists, 2; pharmacologist, 1; Columbia: physiologist, 1; physiological chemist, 1; psychologist, 1; Yale: physiological chemists, 4; physiologists, 2; Harvard: pharmacologist, 1; psychologist, 1; Cornell: physiological chemist, 1; Chicago: physiologist, 1; George Washington University: anatomist, 1; and Pennsylvania: chemist and bacteriologist, 1.

A similar study of men (1903 and 1910 lists combined) with the medical degree shows that of 80 receiving their bachelor degree in a university with a medical department, 40 remained for their medical education while an equal number went elsewhere. Of the first group Harvard claims 16, Pennsylvania 5, Michigan 4, and John Hopkins, Yale and Edinburgh, each 2.

POST-GRADUATE STUDY

As a supplement to Table VIII. is presented an analysis (see Table IX.) of post-graduate study after the winning of the M.D. or Ph.D. degree or in the absence of these, the bachelor's or master's degree. As post-graduate work is included (1) work as a fellow, (2) residence in a teaching or research institution with or without appointment and (3) foreign study. Also where an individual holds both the M.D. and Ph.D. degrees work for the later of these is counted as post-graduate work. When an individual has not held a fellowship and no special course of study is given, the first appointment (as assistant, instructor, lecturer, etc.) after graduation is considered as post-graduate work. Some objection might be raised to including the first appointment as post-graduate study, but as it frequently offers the best criterion of conditions determining future work and of crystallizing the tendencies of the individual, it seems justifiable. On the other hand, if this first position was presumably devoid of opportunities for training, as, for example, a position in a secondary school, it has not been included. In this table, unlike the others, in order to bring out general tendencies, the compiler has freely used his discretion as to omissions at the expense, perhaps, of some of the smaller institutions. Despite all these liberties, the table has been prepared with great difficulty. This has been due in part to the complete absence of all data in connection with some names, and in part to the difficulty of defining graduate work, that is, determining what should and what should not be included. One other difficulty must be mentioned. Although the majority of individuals are credited with postgraduate work in only one or two institutions, some studied in four or more. As a result, in Table IX. the latter have been counted four or more times; thus the same individual may be credited to Columbia, Hopkins, Germany and France, though the total time spent in these four places may not have been greater than that given by another individual credited only to Columbia. To indicate the time element, an attempt was made early in the compilation to indicate length of time of post-graduate study, but this was beset with so many difficulties that it was abandoned. The table, therefore, indicates diversity of post-graduate study by a number of individuals, without regard to the time element, or the sequence of study. For convenience of tabulation foreign universities are grouped under the name of the country in which they are located. So also work in federal, state and city laboratories and in the army and navy are grouped under the head of *Government Work*.

TABLE IX

Post-graduate Instruction; 1903 List Only

	Anat.	Phys.	Chem.	Path.	Bact. and Hyg.	Pharm. and Therap.	Clin. Med.	Surgery, Neurology, Psychiatry, Pediatrics	Totals
Hopkins	13	10	2	8	6	2	3	1	45
Harvard	7	7	1	2	1		2	3	23
Columbia	5	4	2	3	1		1	1	17
Government work	2	1	2	4	4		1		14
Pennsylvania	3	1		1	1	1	5		12
Michigan	5	1		1	2	1			10
Chicago	4	2				1		1	8
Clark	4	1			2				7
Yale		1	4		1				6
Cornell	1	1	1			1			4
Germany	11	13	14	12	5	4	7	1	67
France	1	1	2	2	4		1	2	13
England	1	5	2	1			1	1	11
Austria	1			2	2		1	2	8
Scotland	1	3						1	5
Italy	2	1			1				4

In this table, based on the 1903 list only, institutions or countries credited with less than four post-graduates are not given. The 1910 list, because of the small number of names, can not be conveniently given in tabular form. It shows however that institutions represented by more than one post-graduate are as follows: Harvard, 11; Government Work, 8; Johns Hopkins, 6; Yale and Pennsylvania, each 4; Chicago and Cornell, each 3; and Columbia, 2. Foreign countries are represented as follows: Germany, 13; Great Britain, 5; Austria, 3; France and Canada, each 2.

These figures from the 1903 list indicate clearly the prominent part which Johns Hopkins University has played in stimulating the development of the medical sciences in this country and also the predominant influence of Germany upon American medicine. Germany's lead holds in both lists, but Hopkins and Harvard change places in the 1910 list, while Yale improves its standing at the expense of Columbia, and Michigan and Clark drop out of the list. Just how important these changes are, it is impossible to say on account of the smaller number of names in the 1910 list as compared with that of 1903.

CONSIDERATIONS OF PROFESSIONAL ADVANCEMENT

In preceding tables (VII., VIII. and IX.) have been presented academic and professional education and post-graduate work up to or including the first appointment held. It is now of interest to consider the progress of these various individuals in their later professional life. To this end are presented (*a*) the number of individuals remaining continuously in one, working in two only, or in three or more institutions; (*b*) residence and position of individuals in both groups at the time (1903 and 1910) of Cattell's classifications; (*c*) the length of time between receipt of last degree and appointment as full professor; and (*d*) changes in field of work.

Table X. presents those institutions in which two or more men have labored continuously from time of first appointment. In preparing this table, which includes both 1903 and 1910 lists, scholarships and fellowships have not been considered (these are included in Table IX). Likewise, incidental teaching, research or administrative positions held simultaneously in other institutions, usually of the same city, have also been disregarded.

TABLE X

Continuous Residence in One Institution—85 Names from 1903 and 1910 Lists

	Anatomy	Physiology	Chemistry	Pathology	Bacteriology and Hygiene	Clinical[11]
Cornell	1		1			
Michigan	2			1	2	
Columbia	3	1		1	1	1
Pennsylvania	3	1	1		1	6
Johns Hopkins	2	2		1	1	2
Harvard	2	4[12]		4	1	6
Government	1	1	1	1	3	
Chicago (including Rush Med. College)				3		
Yale		1	3			
Wisconsin	1		1		1	
Western Reserve		1[12]	1	2		
Buffalo				1		1
Bellevue						2
Missouri	2					

In addition to the data presented in the table, the following institutions are to be credited with one man each: Anatomy: Minnesota, Princeton, Smith, Washington and Iowa; physiology: Syracuse, Nebraska, Medico-Chirurgical College and the Rockefeller Institute; bacteriology and hygiene: Wesleyan and Massachusetts Institute of Technology; clinical medicine: Albany Medical College.

In Table XI. is shown the number of men who have worked in only two institutions.

Institutions having one individual in first column only are Toronto, Smith, Edinburgh, Clark, Dartmouth, Virginia, Manitoba, Haverford, St. Louis Medical College, Miami, Georgetown, and Massachusetts, New York and Cincinnati Colleges of Pharmacy; in second column only, Bowdoin, Texas, Minnesota, Western Reserve, Buffalo, Jefferson, Vanderbilt and Simmons.

11 Medicine, surgery, neurology, psychiatry, pediatrics.

12 Including one pharmacologist.

TABLE XI

Service in Two Institutions Only—56 Names—from 1903 and 1910 Lists

	First Position	Second Position
Hopkins	10	5
Michigan	4	1
Chicago (including Rush Medical College)	1	5
Columbia	5	6
University and Bellevue	4	4
Missouri	0	2
Cornell	0	5
Harvard	2	5
Rockefeller Institute	0	2
Yale	3	0
Government work	4	2
New York Polyclinic	2	0
Wisconsin	0	4
Albany Medical College	1	1
California	1	2
Wesleyan	1	1
Northwestern	1	2
Pennsylvania	2	2
Bryn Mawr	2	0
Stanford	2	0
Massachusetts Institute of Technology	0	2

A comparison of Tables X. and XI. shows that of the total of 238 individuals, definite scientific prominence was attained by 85 who remained in one institution and by 56 who had worked in two institutions; of the remaining 97, about three quarters are definitely credited with residence in three or more institutions.[13] On the basis of such a classification it would appear that greater opportunity for successful effort, and therefore greater scientific prominence, attends continuous residence in one institution. On the other hand, if the second and third group are added together, the figures favor migration. The first group, which includes a large proportion of the older men in anatomy, physiology, chemistry and the clinical subjects, is in striking contrast to the condition under the German system; on the other hand, the second and third groups contain a large number of the younger men representing prominence in pathology, bacteriology, hygiene and physiological chemistry, and is suggestive of the principle of migration so characteristic of the German system. Another important point brought out is that a relatively small number of institutions have fostered this selected group, or at least have given them opportunity for attaining prominence. This is shown in Table XII., which is based upon the total number of positions held by 158[14] individuals of the 1903 list only. Only institutions represented by four or more positions are given.

TABLE XII

Institutions and Positions Represented by 158 Individuals of 1903 List.

Institutions	Position					Totals
	Permanent	I.	II.	III.	IV. or Later	
Johns Hopkins	7	19	6	5	3	40
Harvard	12	7	5	1	–	25
Columbia	6	8	7	3	–	24
Michigan	5	0	4	4	1	20
Pennsylvania	10	4	4	–	1	19
Chicago	1	1	8	7	1	18
University and Bellevue	2	4	6	–	–	12
Northwestern	–	1	4	1	1	7
Cornell	2	2	3	–	–	7
Yale	2	3	1	–	–	6
Western Reserve	3	–	3	–	–	6
Missouri	1	–	3	–	1	5
California	–	1	2	1	1	5
Clark	–	1	3	1	–	5
Minnesota	1	–	1	2	–	4
Rockefeller Institute	1	–	2	1	–	4
Foreign Universities	–	7	1	1	1	10
Federal, State, City and Hospital	6	3	2	6	5	22
Grand total						239[15]

Table XII. shows 239 positions divided in 18 ways. If foreign universities, federal, state and city and hospital positions and the Rockefeller Institute are removed, we have 203 positions divided among only 15 universities. As the total number of positions occupied by the 158 individuals was 314 it is evident that

[13] The data concerning twenty-one is either incomplete or too indefinite for tabulation in this regard.

[14] Twenty-one names are omitted because of unsatisfactory or indefinite data.

[15] Institutions represented by less than 4 men total 75 positions, making a final total of 314 positions.

these fifteen universities were responsible for two thirds of the opportunities offered for advancement in the sciences of medicine in this country up to the year 1903. The institutions offering more than ten positions are seven in number, Hopkins, Harvard, Columbia, Michigan, Pennsylvania, Chicago and New York University,[16] in the order named, with a total of 158 positions or almost exactly half of the positions (314) represented by the total number of individuals.

PRESENT DISTRIBUTION WITH RANK

Table XIII. presents the distribution of the entire 238 individuals and their rank as given in the 1906 and 1910 editions of "American Men of Science." Persons characterized as "emeritus" or "retired" are credited according to their last appointment. Nine men in active service in 1906 are not included in the table; these represent two men called to foreign universities, a medical clinician, a specialist in tuberculosis—the last two without university affiliation—a librarian, and four men whose later records are incomplete. The table thus really includes only 229 individuals.[17]

TABLE XIII

Distribution and Rank; 1903 and 1910 Lists; 229 Names

	Professor	Adj. or Associate Professor	Assistant or Junior Professor	Instructor, Lecturer, Associate or Assistant	Director, Chief or Curator	Emeritus or Retired	Totals	Gains in 1910
Harvard	15	3	3	4			25	8
Hopkins	9	8		1			18	3
Columbia	10	3		3		2	18	4
Pennsylvania	12			1	3		16	5
Chicago (incl. Rush)	5	6	2	1			14	4
Cornell	9	1	2		1		13	4
Federal and state depts.					11		11	4
Michigan	8			1			9	1
Wisconsin	5			2			7	3
California	2		2	2			6	0
N. Y. University and Bellevue	5					1	6	1
Rockefeller Institute					6		6	2
U. S. Army and Navy and P. H. Service	1				2	2	5	1
Western Reserve	4					1	5	3
Minnesota	2		1	1			4	0
Northwestern	3	1					4	0
Missouri	2	1	1				4	1
Yale	2		2				4	2
Hospitals					4		4	2
Wesleyan	2	1					3	0
Illinois	3						3	1
Mass. Institute of Technology	1			2			3	1
St. Louis Medical School	1				1		2	0
Buffalo	2						2	0
Philippine Med. School	2						2	2
Stanford	2						2	1
Indiana	1	1					2	1
Other Institutions	24	3	1	1	2	1	31	5
Not classified							9	0
Totals							238	59

It is of interest also that this very definite support of scientific medicine concerns almost entirely the university schools; independent medical schools play little or no part in this table.

[16] Including the old New York University and Bellevue Hospital Medical Schools.

[17] Only institutions represented by two or more places are given in the table. Other institutions represented by one professor are: Bowdoin, Texas,

In Table XIV., based on the 1903 list only, is shown the lapse of time, in the several broad groups representing medicine, between the receipt of last degree and attainment of full professorship, and also the number in each group who have reached prominence without the grade of full professor. The number of individuals in this table is only about two thirds (140) of the total number (179) studied. The names omitted represent those who do not fall readily into the groups given, who are without academic affiliation, or whose records are incomplete. Those who taught two subjects, as anatomy and physiology, and those who held two chairs in succession, as, for example, a clinician, temporarily the occupant of a chair of pathology, are classified more or less arbitrarily according to their greater prominence in one or the other of the subjects named, but each is counted only once.

TABLE XIV

Lapse of Time between Degree and Full Professorship. 1903 List, 140 Names

	Totals	1–2 Years	3–5 Years	6–10 Years	11–20 Years	20–27 Years	Average No. of Yrs.	Lower Grades
Anatomy	41	7	4	9	4	2	8	15
Physiology	27	1	4	6	5	1	9	10
Physiol. chem. and pharmacology	19	5	5	6	0	0	4	3
Pathology, bacteriology and hygiene	30	1	7	8	6	1	8½	7
Clinical	23	0	0	8	6	6	14½	3
Totals	140	14	20	37	21	10		38

It is seen that in anatomy, physiology, pathology and bacteriology the average wait is about the same, eight to nine years; in physiological chemistry and pharmacology it is low —four years—all full professors in these subjects having been appointed within ten years of their graduation; in clinical medicine the average is nearly double that of the other branches. The early average in physiological chemistry and pharmacology is, in all probability, due to the rapid development of these subjects as a part of the curriculum of the modern medical school; the high average in medicine is doubtless to be explained by the old custom of appointing only prominent consultants to chairs of medicine. An analysis of the appointments in anatomy indicates that the large number of early appointments is to be explained by the comparatively recent policy of divorcing the teaching of anatomy from that of physiology and surgery, which has thrown open many chairs to the younger men specializing in anatomy. Only in the clinical branches apparently has there been, in the past, much chance for a man to be called to a chair after twenty years. Considering all branches the largest number of individuals reached professorial rank during the second five-year period after graduation.

The individuals who have attained prominence without becoming full professors present great variation in lapse of time after graduation; in anatomy the extremes are one and twenty-five; in physiology, two and thirteen; in physiological chemistry, two and ten; in pathology and allied subjects, one and eleven; in clinical medicine, nine and twelve. It is noteworthy, however, that of the entire group of thirty-eight individuals representing grades lower than professor, only six had been graduated more than ten years.

Clark, Iowa, Princeton, Knox, Smith, Syracuse, Tufts, Medico-Chirurgical of Philadelphia, Vanderbilt, Woman's Medical College of Philadelphia, Chicago Homeopathic Medical College, Eclectic Medical Institute of Cincinnati, Virginia, Pittsburg, Ohio, Washington and Lee, Washington University, George Washington University, the Jefferson, Denver and Albany Medical Schools and New York College of Pharmacy; by lower grades of title, Simmons, Dartmouth, Bryn Mawr, Nebraska and Georgetown; by a director, Pennsylvania State College and a commercial laboratory.

CHANGE OF FIELD OF WORK

That success or prominence in a given field is necessarily the result of continuous single-minded effort in that field is supported by an analysis of the 1903 list. Excluding concurrent appointments, the interacting interests of the group representing physiology, physiological chemistry and pharmacology and the very natural communion of interests shared by pathologist and clinician, there is very little tendency to change in field of effort. Two

anatomists had an early brief experience in pathology and one in physiology. Three physiologists started as anatomists, but changed their interest early in their career. Some of the physiologists and chemists entered the field of pharmacology, and some of the latter that of pharmacy also, but in no instance have they been interested in other branches.

Three pathologists had initial appointments in anatomy or histology, and one in clinical medicine. One bacteriologist had an early appointment in chemistry.

THE CLINICIAN AS AN INVESTIGATOR

Of the clinical group, five individuals had been professors of pathology, while two had held chairs of materia medica, one a chair of botany and therapeutics and one a chair of anatomy. Three others had been, respectively, professor of hygiene, physiology and the institutes of medicine. Of those who had not held chairs, three had done notable work in pathology, one in physiology and toxicology and one in clinical hematology (microscopy). These activities are naturally those closely related to diagnosis and treatment, respectively, and it is probably these activities in the science of medicine, and not the actual practise of medicine, which gave the individuals in question their prominence as men of science. The history of medicine in this country shows that the first medical laboratories, presided over by men who did not practise medicine, were those of chemistry. Anatomy and physiology, at first in the hands of the clinicians, were the subjects next to acquire laboratory facilities and full-time men. Still later, pathology was divorced from clinical teaching and became a laboratory subject. But until about twenty to twenty-five years ago, the advancement of the medical sciences, aside from chemistry, was largely in the hands of clinicians, and it was men of the type represented in this list—as Mitchell, Delafield, Fitz and Janeway—who kept the scientific side of medicine alive in the period preceding the development of our present manifold laboratory activities. That twenty men in internal medicine and thirteen men in surgery and the specialties—men busily engaged in the actual practise of medicine—should constitute almost one fifth of a list of 179 prominent medical men of science, the majority of whom are laboratory men, is a matter for sincere congratulation. It will be interesting to see whether or not the new conditions in medicine, the full-time chairs in clinical medicine and the better equipped clinical and research laboratories, yield as large a number of prominent scientists in clinical medicine. The 1910 list with its 59 new names is too small and too near the 1903 period to be of value. It shows only two new names in internal medicine, three in psychiatry, two in neurology, three in surgery and none in pediatrics, as contrasted with twenty, three, three, two and three in 1903. For psychiatry, neurology and surgery this is an excellent showing; for internal medicine and pediatrics, opinion must be deferred.

Richard M. Pearce
University of Pennsylvania

THE NATIONAL FORESTS

The first-hand impressions and experiences gained on his thirty-day tour of the National Forests are described as "invaluable" by Secretary of Agriculture Houston in a letter which he sent on his return to Washington to the chief forester, expressing his approval of the administrative work and methods of the forest service.

Starting out with the expressed intention of seeing the work with his own eyes and studying on the ground the principal problems involved in managing and developing the forest resources of the country, Secretary Houston visited typical forests in each of the six great forest districts of the west, penetrating into the wilds on logging locomotives, automobiles, horseback, and at times on foot, and getting into personal touch, not only with the rangers and guards, but with homesteaders, cattlemen, lumberjacks and others among whom the forest officers do their work. Secretary Houston in his letter to the forester says:

I especially desired to familarize myself with the administrative machinery and business methods, to acquaint myself with the grazing condi-

tions, the water-power developments, the timber operations, the relation of the forests to agriculture, the road and trail and other improvements, the recreational use of the forests, other uses, and to see some of the typical homestead claims. I was afforded an opportunity to see typical forests in each of the districts and some of the more striking operations of each of them.

I regret that it was physically impossible for me to visit more of the forests in each district. I feel, however, that I accomplished my main purposes and that the results of my trip are invaluable. I was exceedingly gratified with the evidence of enthusiasm, loyalty and devotion to duty on the part of all representatives of the department with whom I came in contact. I was especially impressed with the intelligent and sympathetic attitude between the forest service and the users of the forests and of all communities dependent upon them. It was pleasing to observe that in the forests themselves the residents and other users look to the forest officers, not only for information bearing on forestry problems in which they are interested, but also for assistance in many other matters. The efficient and sympathetic handling of forestry problems on the part of the service, in the interest not only of the nation, but particularly of the sections in which the forests are located, gives promise of the successful solution of any problems that may confront us.

In a statement supplementing his letter, Secretary Houston said that among the first of the activities with which he came in contact was the recreational use of the national forests, under which upward of a million persons every year travel, camp, hunt, fish or maintain summer homes and resorts in the forests. The tour of inspection began on the Santa Fe forest, New Mexico, where many summer homes have been built in the mountains. In the Coconino and Tusayan forests, Arizona, which border the famous Grand Canyon, the secretary was particularly impressed, he said, by the necessity of improvements which will make the canyon more accessible to the public and which are being constructed by the forest service on these and other forests as rapidly as funds permit, nearly 8,000 miles of road and 21,000 miles of trail having been built on all of the national forests up to date.

On the Angeles forest, in southern California, the secretary said, he saw a striking illustration of the importance of forest protection of watersheds, which in this locality has contributed to the irrigation development that in twenty years has transformed a desert into one of the most flourishing agricultural sections of the country. He visited some of the 1,100 towns and cities which derive their domestic water supply from national forests and, after crossing the Sierra Nevada range in an automobile that was fitted to the railway with special, flanged wheels, he inspected one of the largest water-power projects on the forests, a fourteen-million-dollar plant operated under permit on the Sierra National Forest. With regard to water-power, development of which is going on actively under the Department of Agriculture's regulations, the secretary said that he saw no need for a change in the existing system of control, except for legislation to permit long-term leasing of water-power sites.

Stock owners in the west, said the secretary, are more than satisfied with the departmental regulations under which improved range conditions are brought about along with the grazing of increasing numbers of livestock, of which more than fifteen million, mainly sheep, cattle and horses, now graze annually on the national forests. In the logging and mill operations on some of the big timber-sale projects in the Douglas fir country of Oregon and Washington, the secretary said, he was enabled to get much first-hand knowledge of fire protection and conservative logging as carried on under government regulation, and he commended the reforestation work for which from ten to fifteen million trees are grown annually in forest service nurseries.

The secretary completed his tour in Montana after he had had a personal insight into practically all of the important activities of the forest service and, as he said, obtained first-hand impressions not only from forest officers, but from all classes of local residents who are affected by the methods and regulations under which the national forests are being administered in every section of the west.

SCIENTIFIC NOTES AND NEWS

The American Society of Zoologists will meet from December 28 to December 31, inclusive, at the State University of Ohio, Columbus, simultaneously with the meeting of the American Association for the Advancement of Science.

Officers of the American Astronomical Society were elected at the Pacific Coast Meeting as follows:

President, Edward C. Pickering.
First Vice-president, W. W. Campbell.
Second Vice-president, Frank Schlesinger.
Secretary, Philip Fox.
Treasurer, Miss Annie J. Cannon.
Councillors, W. S. Eichelberger, J. S. Plaskett, E. B. Frost, Joel Stebbins.

The Swiss Society of the Natural Sciences, the national association for the advancement of science, meets this year at Geneva, from September 12 to 15. It is the ninety-seventh annual meeting of the society and the hundredth anniversary of its foundation, but in view of the existing circumstances this anniversary will be celebrated in only a simple way, and the usual invitations to foreign scientific societies and scientific men are this year omitted. The papers before the general sessions, partly in French and partly in German, are as follows: "New Light in the Investigation of the Jura Mountains," by Professor A. Heim, of Zurich; "Results of Forty Years of Measurements of the Glacier of the Rhone," by Professor E. L. Mercanton, of Lausanne; "An Archipelago of the Pacific," by Dr. Fritz Sarasin, of Basle; and "The International Phyto-geographic Excursion through North America," by Dr. E. Rübel, of Zurich.

Charles Lee Crandall, professor of railway engineering and geodesy in the college of civil engineering of Cornell University, from which institution he graduated in the first class and where he became a teacher in 1872, has retired from active service. Both the university faculty and the trustees have passed resolutions in appreciation of his services to the university.

Dr. Albert C. Seward, professor of botany in the University of Cambridge, has been elected master of Downing College, in succession to the late Professor Howard Marsh.

The Moxon gold medal of the Royal College of Physicians has been awarded to Professor J. J. Déjerine, and the Baly gold medal to Dr. F. Gowland Hopkins.

The Munich School of Technology has conferred its doctorate of engineering on Dr. von Brill, professor of mathematics at Tübingen, and on Dr. Schwager, of the Geological Survey.

Dr. M. Standfuss and Dr. A. Querbain have been made honorary professors in the University of Zurich, the former in entomology, the latter in meteorology.

Dr. Ernst Schmidt, professor of pharmacological chemistry at Marburg, has celebrated his seventieth birthday.

Professor Béhal has been made director of a department for the study of questions of chemical manufacture with special reference to the war, established by the French ministry of commerce in the Paris School of Pharmacy.

Dr. Jakob von Weyrauch, professor of engineering in the Stuttgart School of Technology, has retired from active service.

An action was brought in the Chancery Division by Professor Arthur Schuster, one of the secretaries of the Royal Society, against the publishers and printer of *Pearson's Weekly*, in respect of an article suggesting that Professor Schuster's private wireless apparatus was discovered and "seized." Defendants offered an ample apology, paid the costs, and gave fifty guineas to the Red Cross funds.

Professor E. L. Nichols, of the department of physics of Cornell University, who has leave of absence for the first term of the coming year, will spend that period in the far east.

Dr. A. J. Herbertson, of Wadham College, Oxford, professor of geography in the university, and well known for his contributions to geography and meteorology, died on July 31, at the age of fifty years.

Dr. Edmund Owen, a London surgeon who had made contributions to surgery and anatomy, died on July 23.

THE death is announced in his seventy-second year of Mr. George Newlyn, formerly connected with the Kew Botanical Garden and a writer in popular science.

M. F. P. J. GUÉGUEN, late professor of botany in the School of Agriculture at Grignon, has died at the age of forty-three years.

DR. JIORDANO, professor in the University of Palermo, known for his work on the diseases of miners, died on July 10.

DR. ALFRED SCHLIZ, the German anthropologist, has died at Heilbrun, at the age of sixty-six years.

FOLLOWING out the provisions of the late Mrs. Keenan, who left $300,000 to establish and maintain a free medical dispensary in Milwaukee, a meeting is soon to be held between the trustees of the fund and the city health department to work out the arrangements as contemplated in the will.

DURING the present summer the regents of the University of New Mexico have instituted a survey of the lands in the university state endowment, of which there are nearly 300,000 acres still owned by the university. Charles T. Kirk, of the New Mexico Natural Resources Survey, and John D. Clark, of the department of chemistry at the University of New Mexico, have been placed in charge of the work.

UNIVERSITY AND EDUCATIONAL NEWS

DR. EDGAR NELSON TRANSEAU, now a professor in the Southwestern Normal School, Charleston, Ill., goes to Ohio State University next year as professor of plant physiology.

PROFESSOR ROY H. PORTER, of Iowa State College, has become head of the department of mechanical engineering at the New Hampshire College to succeed Professor Richard E. Chandler resigned. Professor Porter took his B.S. degree in mechanical engineering at the University of Maine in 1906 and the degree of mechanical engineer at Iowa State College in 1912. He has been instructor in mechanical engineering at Iowa State College, was made assistant professor there in 1908 and associate professor in 1913.

AT Bryn Mawr College Dr. Frederick H. Getman, associate professor of chemistry, has resigned, and Dr. James Llewellyn Crenshaw has been appointed associate in physical chemistry. Dr. Crenshaw has been instructor in chemistry in Centre College and in Princeton University. From 1911 to 1915 he has been research assistant in chemistry in the Carnegie Institution of Washington.

DR. P. H. RÖMER, director of the Institute of Hygiene at Greifswald, has been called to Halle as successor to Professor Fränken.

PROFESSOR HARRIES, of Kiel, director of the chemical laboratory, has declined a call to Göttingen.

DR. KONRAD PICHORIUS, professor of ancient history at Breslau, has been appointed professor at Bonn, as successor to Professor Ulrich Wilcken.

DISCUSSION AND CORRESPONDENCE

ELEMENTARY MECHANICS

THE letter of Professors Franklin and MacNutt[1] is a helpful contribution to the discussion of the laws of motion. I wish especially to endorse their remarks upon the law of action and reaction. The idea that action and reaction, because equal and opposite, are balanced forces, is responsible for more confusion, perhaps, than any other error connected with the laws of dynamics. An instance of this occurs in a comparatively recent article in which the author assumes that a body acted upon by an unbalanced force must be retarded by an equal and opposite "ether-friction" in order to satisfy the law of action and reaction; forgetting that if such were the case the force would really be balanced and the body would have no acceleration. The explanations given by Professors Franklin and MacNutt of the second law of motion and of popular and scientific usage regarding the terms mass and weight are also, in the main, calculated to promote clear thinking about these matters. That "the result of weighing a body on a balance scale" is a proper measure of "amount of material," however, certainly requires explanation to the beginner.

The writers apparently attribute to me some

[1] SCIENCE, July 9, 1915, p. 56.

part of the responsibility for the hopeless confusion which they allege exists regarding the distinction between mass and weight. Their own explanation of this matter however differs from mine chiefly in the picturesqueness of the language employed. I have, indeed, recognized[2] that if full rigor is insisted on it is necessary to make a distinction not mentioned by Professors Franklin and MacNutt. The word weight, according to scientific usage, does not usually mean the actual "force with which the earth pulls on a body," but something which differs from this because of the earth's rotation. I have not advocated introducing this distinction in the first explanation of weight to students; but it can not be permanently avoided if any important attainment is reached in the study of dynamics.

Since the writers have referred to me in connection with the meaning of the division by g, I may say that I certainly am not one of those who believe that weight is converted into mass by dividing by g or by any other process. I believe, however, that the fact should be made clear that mass, like any other measurable magnitude, is expressible in different units; and that the reduction from one unit to another involves precisely the same kind of reasoning in the case of mass as in the case of length or velocity. One can not understand the reduction of a length from feet to meters unless he understands the meaning of both the foot and the meter; a similar statement holds concerning the reduction of a mass from pounds to tons, or from pounds to "slugs." Moreover, I see no reason why the unit which has been called the slug should be regarded with ridicule, or even with semi-ridicule. The question of what unit to employ for any given purpose is properly decided by convenience. The convenience of the "slug" is due to two facts—(1) that the pound-force is customarily employed in a great deal of practical work and (2) that the dynamical formulas almost universally used are based upon a relation of units such that *unit force acting upon unit mass causes unit acceleration.* And there should be no more difficulty in understanding the definition of the "slug" than that of the dyne or the "standard pound-force" or any other unit which is defined by an appeal to the law of acceleration.

L. M. Hoskins

[2] Science, April 23, 1915, p. 611.

QUOTATIONS

BRITISH SCIENTIFIC MEN AND THE GOVERNMENT

In addition to appointing committees to consider suggestions or inventions, the Royal, Chemical and Physical Societies have taken steps to obtain registers of their fellows classified according to special knowledge and to scientific services which the fellows are willing, as well as specially qualified, to perform. The idea in each case is to secure cooperation among the fellows of the particular societies, and to examine by means of committees any promising suggestions relating to munitions of war or kindred subjects. No one knows precisely what will be done with the registers when they have been completed. Each society seems to be compiling its list independently and without any clear view of the use which will be made of the experts' services which will become available by the response to its circular. No scheme has yet been put forward by which definite national duties will be assigned to the hundreds of scientific men who are enrolling themselves on the registers of their respective societies. . . .

The laboratories of our universities, university colleges and technical institutions are at the disposal of the government, and in many of them men are devoting twelve hours a day to work in connection with the supply of munitions of war. A few days ago the members of the Royal Institution decided to offer the resources of their laboratories and of the Davy Faraday Research Laboratory to the government for the prosecution of any particular research by officers of the admiralty, war office or ministry of munitions; and the managers invited communication from these departments "in case there is any field of research in relation to or connected with chemical and physical science, or either of them, to which the professors, assistants and staff of the Royal Institution or of the laboratory can usefully direct their attention with the view of

giving assistance to his Majesty's government in the conduct of the war."

We notice that this resolution was sent to the First Lord of the Admiralty, the Minister of War, the Minister of Munitions and the chairman of the Inventions Board of the Admiralty, but we can scarcely suppose that each of these officers of state will act independently in making whatever use is possible of the offer. Mr. Lloyd George has announced in the House of Commons that he has made arrangements with the Secretary of State for War to take over the invention work relating to the munitions of war for the supply of which his department is responsible. He has also arranged with the First Lord of the Admiralty to take over the work relating to new expedients and inventions for purely army purposes which are at present in charge of that department. . . .

Most people assume that these services will be voluntary; and a correspondent directs our attention to the fact that in the forms circulated by the Physical Society in connection with the proposed "War Register," it is stated that: "It is to be understood that all service would be voluntary, and unpaid, being given for the good of the country during this period of emergency." He adds: "I should like to inquire how it comes about that the Physical Society is not in a position to offer remuneration for work of the character specified in the circular on a scale at least bearing a reasonable proportion to the wages paid by the government for the performance of less responsible labor. Is it really for the good of the country that this work should be unpaid?"

Government departments and statesmen find their requests for expert advice and guidance responded to so willingly by scientific men and societies that they overlook the necessity of making any recompense for work done. In the medical services every qualified practitioner receives rank and reasonable pay, while consultants are given generous retaining fees. In legal circles also no advice is expected without a retainer being attached to it; and in this connection we are interested in the announcement that "according to a statement made in the House of Commons Sir John Simon, as attorney-general, drew £18,000 as his remuneration for the past year." It should be unnecessary to urge that the laws of nature are of as much importance as the laws of the land, and that as in the present crisis men of science can be of greater service to the nation than lawyers or politicians, they should receive at least sufficient reward for it to enable them to put aside their daily work in order to take up national duties. There will be no lack of volunteer workers among scientific men, but the state should understand that its responsibility for payment on account of expert opinion is at least as great in the case of science as it is in law, medicine and engineering.—*Nature*.

SCIENTIFIC BOOKS

The Social Problem, A Constructive Analysis. By CHARLES A. ELLWOOD, professor of sociology in the University of Missouri. In the Citizens' Library of Economics, Politics and Sociology. Edited by RICHARD T. ELY, professor of political economy in the University of Wisconsin. New York, The Macmillan Co., 1915. Pp. 249. $1.25.

"The present crisis in our civilization," we are told in the preface of this book, "calls for a reconstruction of our social philosophy." The author confidently undertakes the task. Decay is noted in religious belief, moral ideals, political honor, conflict of classes, the breakdown of regulation and control, the demand for a strong man and centralization in government. "The very forces which undermined Roman civilization, viz., commercialism, individualism, materialistic standards of life, militarism, a low estimate of marriage and the family, agnosticism in religion and ethics, seem to be the things which are now prominent, if not dominant, in Western civilization." Many new problems have suddenly arisen from increase of population, increase of knowledge, intermingling of races and cultures, increasing interdependence of nations, the invention of new machines and various other developments.

Back of these problems lies *the* social problem. Reformers who emphasize special problems do not grasp it. Those whose vision is

limited to national interests or whose point of view is purely economic have not discovered it. Pacifist, eugenist and feminist all miss it. Rather is it known only by those "who are beginning to perceive that the social problem is now what it has been in all ages, namely the problem of the relations of men to one another." These relations are the outcome of concrete historical, physical, physiological, economic and ideal elements. For example, on the historical side the relations of men in western civilization are largely determined by inheritance of Greek, Hebrew, Roman and Teutonic customs and ideals. Briefly attempting to characterize some of the chief contributions of each of these factors, the author endeavors to show how various inharmonious elements in them have combined with specified unfortunate effects of physical and economic influences to produce undesirable conditions in present society. A final chapter, on "The Solution of the Social Problem," lays down a number of precepts. To "solve" the social problem we must take a synthetic view of our social life, avoid revolution and violence, develop sympathy among all classes in the population, advance education, purify family life, control heredity, inculcate social responsibility, stress reason and altruism, support science, readjust the economic system and finally as a means to all this find and train social leaders.

In covering so large a field in so short a volume Professor Ellwood has necessarily dealt in cavalier fashion with most of his topics. In consequence the cautious scientist who looks in this book for adequate proof of all positions taken will be disappointed. The discerning reader, nevertheless, may possibly draw the not-unscientific conclusion from it that the world is still full of a number of things that need careful investigation. It is to be feared, however, that not all into whose hands "The Social Problem" falls will be able to distinguish opinions from generalizations that have been established through the work of numerous investigators.

A. A. Tenney

Columbia University

SPECIAL ARTICLES

NEW METHODS IN SOIL PROTOZOOLOGY[1]

In the investigation of a problem bearing on the conclusions of Russell and Hutchinson[2] who consider protozoa as one of the limiting factors of bacterial activity and consequently of soil fertility, the authors found it expedient to carry on several preliminary experiments for the purpose of establishing the value of certain newly devised methods.

In view of the fact that the methods employed for counting protozoa have been unsatisfactory even in the hands of such experienced investigators as Rahn,[3] using an application of the bacterial dilution method; Killer[4] plating on solid media; Müller[5] counting protozoa per standard loopful of solution; and numerous others counting the protozoa directly in a drop by means of a microscope; the authors have adapted the well-known blood-counting apparatus (Blutkörperzählapparat) to the counting of protozoa. The principle underlying the use of this instrument is the microscopical observation of a drop of standard size. The organisms may be examined in the stained or unstained, in the living or dead state. Picrosulphuric acid (Kleinenberg) is recommended for killing and rapid staining simultaneously.

The calculation of results is based on the use of a standard stage micrometer, the squares marked on the disc of the slide, and the constant depth of solution under observation, which is .1 mm. Thus no mechanical variation is possible. The advantages of using this apparatus for counting protozoa are as follows:

1. It is a direct method, thus eliminating many errors attending incubation, etc., and the results can be reported immediately.

[1] From the laboratories of Protozoology and Soil Bacteriology. Further results of experimentation and a bibliography on soil protozoology and soil sterilization are awaiting publication in coming issue of *Centr. f. Bakt.*, Abt. II.

[2] Russell and Hutchinson, *Jour. Agr. Sci.*, 3 (1909), 111; *ibid.*, 5 (1913), 152, etc.

[3] Rahn, O., *Centr. f. Bakt.*, II., 36 (1913), 419.

[4] Killer, *Centr. f. Bakt.*, II., 37 (1913), 321.

[5] Müller, *Archiv. f. Hyg.*, 75 (1912), 321.

2. It is more accurate than any other method in use, because it is a standard instrument and no mechanical variation is possible.

3. It is rapid and saves considerable time in contradistinction to other methods, and the technique is simple. For example, triplicate counts on any medium were recorded in ten minutes.

4. The counts check more closely than those of any other method.

5. It can be used to advantage whether the number of protozoa present be large or small.

6. It can be used for living, killed or stained organisms and permits of a thorough observation of the individual organisms.

Its disadvantages are that the initial cost is greater than that of other methods, and the sample is too small to be representative. The error of count is considerable where the protozoa are very few or many in number. And a number of fields must be counted because of the uneven distribution, if an accurate count is required.

Despite the logical thoroughness of Russell and Hutchinson's work, there appears to be one point which they seem to have neglected. Namely, the production of ammonia, etc., is used as a criterion for measuring the effect of soil protozoa on bacterial activity, while the fungi in the soil, which are known to be capable of producing ammonia,[6] were not taken into account. Thus there is an added unrecognized factor operating in their experiments as well as those of others, *i. e.*, soil fungi.

Taking cognizance of this factor, a method was devised for its elimination, based upon the principle of dilution, in such a way as to reduce the possibilities for the occurrence of fungi. The method of procedure was to pour plates of ten different fungi media in duplicate. These agars were: potato, oat, cornmeal, rice, bean, raisin, apple, synthetic, soil extract and Cook and Taubenhaus's No. 2.[7]

Upon cooling, a block of each medium about 2 cm. square was cut out with a sterile knife, and 1 c.c. of sterile soil extract was introduced by means of a sterile pipette into the cavity formed. A platinum loopful of a three-day-old culture of soil organisms in soil extract, known to contain numerous bacteria, protozoa and fungi, was then carefully rinsed off in the medium occupying the cavity.

At the same time poured plate cultures of one loopful of the three-day-old culture of organisms were made on the ten different agars mentioned above. Likewise after one week poured plate cultures were made on the ten different media by inoculation with one loopful of the solution present in the cavity of the agar plate.

The results show that on the plates where a portion of the agar was removed and 1 c.c. of soil extract substituted, the bacteria and protozoa developed in large numbers, which might in all probability be due to the fact that a large surface is exposed for such a small quantity of media. The important point, however, which is to be noted from this experiment is that despite the fact that suitable media were furnished for the growth of fungi, none was evident, even after thirty days' incubation.

From the observation of the poured plate cultures made from the original three-day-old culture we note that fungi appear after four days upon three out of ten plates; namely, No. 2, synthetic,[8] and raisin agars. The fungi predominating were species of *Penicillium, Alternaria* and *Fusarium.*

On the poured plate cultures made from the solution in the cavity of the agar plates, no fungi developed. This experiment was repeated and corroborated the previous results.

Thus it is certain that whereas fungi were present in the original culture the process of high dilution was responsible for their elimination from the specially prepared cavity on the agar plates.

Thus the dilution method followed by the peculiar manner of plating, as outlined, makes it possible to separate fungi from bacteria and

[6] Müntz and Coudon, *Compt. Rend.*, 116 (1893), 395.

[7] Cook and Taubenhaus, Dela. Bull. No. 91 (1911), 11.

[8] Lipman and Brown, N. J. Ann. Rpt. (1908), 132.

protozoa. And as a result of this separation, it is possible to eliminate fungi from experiments involving the effect of protozoa upon bacterial activity, by making a subculture from the fungi-free solution of bacteria and protozoa (in the cavity of the agar plate).

Some studies on the comparative value of different media for the development of soil protozoa, somewhat after the manner of Cunningham and Löhnis[9] and others, were carried out with hay infusion, with and without the addition of .5 per cent. egg albumen (Goodey), peptone, dried blood, soil extract (Löhnis), horse, cow and chicken manures (Martin) and egg albumen. The above media were employed in dilutions of .5 per cent., 1 per cent., 3 per cent., 5 per cent. and 10 per cent.

A condensed table[10] of maximum numbers (counts made on five succeeding days by means of the Blutkörperzählapparat previously described) is given below:

Days	Large Ciliates	Large Flagellates	Small Ciliates	Small Flagellates
1	8,520 in soil ex. 800 cc.	840 in 10 % hay	4,255 in 5 % D. B.	28,750 in 5 % D. B.
2	63,800 in horse .5 %	709 in 5 % egg albumen	9,210 in 3 % chicken	282,000 in 5 % horse
3	319,010 in 10 % hay	10,625 in 10 % hay	208,000 in 3 % chicken	636,500 in soil ex. 1,000 cc.
4	708,000 in 10 % hay	7,435 in 5 % cow	379,000 in 3 % egg	478.000 in 1 % horse
5	1,410,000 in 10 % hay and egg	319,000 in 5 % cow	804,000 in 3 % egg	1,878,000 in 3 % hay and egg

Summary

1. Ten per cent. hay infusion proved to be the most favorable medium for the development of large numbers of small flagellates, as well as small and large ciliates. Hay infusion in various concentrations, with and without the addition of egg albumen, proved to be well adapted to the development of the organisms. Hay infusion plus .5 per cent. egg albumen proved superior to all other media for the development of ciliates.

2. Soil extract is an excellent medium, though somewhat inferior to hay infusion plus .5 per cent. egg albumen and with the soil used in this experiment lower concentrations than those recommended by Löhnis, developed protozoa in a shorter period of time.

3. Three per cent. chicken manure is an excellent medium for the development of small ciliates.

4. The numbers and species of protozoa which can be obtained from a given soil are largely dependent upon the media employed, time of incubation, as well as the kind of soil used.

5. In general the order of appearance of protozoa was as follows: small flagellates, small ciliates, large flagellates (if appearing at all) and finally large ciliates. This confirms Cunningham and Löhnis's observations.

Nicholas Kopeloff,
H. Clay Lint,
David A. Coleman
New Brunswick, N. J.,
February 25, 1915

[9] Cunningham and Löhnis, *Centr. f. Bakt.*, II., 39 (1914), 596.

[10] Kopeloff, Lint and Coleman, *Am. Mic. Soc.*, 34, No. 2 (1915), 149, *Jour. Agr. Res.*, 4, No. 6 (1915).

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The Botanical Society of Washington entertained at an informal dinner at the Cosmos Club, on Thursday evening, July 22, 1915, Dr. F. Kølpin Ravn, of Denmark, Dr. Otto Appel, of Germany, and Dr. Gentaro Yamada, of Japan. Mr. M. A. Carleton welcomed the guests, each of whom responded.

Dr. H. B. Humphrey commented on the services rendered to cereal pathology by Dr. Ravn's travel and studies in the United States this season.

Dr. W. A. Orton gave a full account of the travel of Dr. Appel and his investigations of the potato diseases in this country during the past year.

Dr. E. F. Smith emphasized the importance of wide travel and experience to botanical investigators.

Dr. C. L. Shear spoke on international phytopathology, and expressed a hope that within a short time there may be organized an international society of plant pathologists.

Perley Spaulding,
Corresponding Secretary

SCIENCE

FRIDAY, SEPTEMBER 3, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

RECENT STUDIES ON THE BIOLOGICAL EFFECTS OF RADIOACTIVITY[1]

X-RAYS were discovered in 1895 and the first of the publications which placed Madame Curie, the discoverer of radium, in the position of foremost woman of science, appeared in 1898. The application of these results to biology, a matter of great importance, was brought about through accident. A knowledge of the physical properties of radio-active substances would lead one to expect that the physiological action would be acute, and that fact was accidentally proven to be true.

Becquerel carried a small tube of an impure radium preparation in his vest pocket for six hours. A few days later he observed a reddening of the epidermis of the abdomen opposite the location of the pocket in which he had placed the radium compound. It was not long before the inflammation became pronounced, and an ulcer developed which required several months for the healing.[2]

Giesel exposed the inner portion of his arm, for two hours, to 0.27 gram of a radium preparation, enclosed with a double celluloid capsule. After two or three weeks the skin reddened, blisters formed and the epidermis peeled just as with a burn. The growth of hair was also destroyed and did not come out anew, although a smooth white skin reformed.

Madame Curie had learned very early in her studies that radiation affects tissues, for she says in her thesis, "The action of radium upon the skin can take place across metal screens, but with weakened effect."

Thus early began the application of a

[1] Contribution from the Zoological Laboratory of the University of Texas, No. 125.

[2] From Baskerville, "Radium and Radioactive Substances," Williams, Brown and Earle, Philadelphia, 1905.

method which has now an established place in therapeutics, in the treatment of skin diseases, warts, tumors, cancers, etc. An imposing list of literature from the clinical standpoint bears witness to the practical importance of radioactivity, and many contributions show the interest of medical men. Now all physicians must be familiar with the results of work in this line, and, in addition, every city boasts its experts and specialists in radiography and radiotherapy.

Thus far, however, clinicians have been chiefly concerned with the formulation of effective methods of treatment, and it has been left for the biologists rather than the physicians to analyze the effects of radioactivity upon living matter.

The attack on the problem of the effect of radioactivity on tissues and organisms and the use of radioactivity as an experimental means of studying questions of more fundamental biological importance was at first insignificant. Even yet our knowledge of the effects is very meager; and to our ignorance of the deeper-lying basic principles which govern the action of radium and of X-rays is due the uncertainty with which the extension of the methods to new fields and new problems is viewed by many medical men. The analysis of the effects has been taken up only recently and progress in the investigation has not been rapid, with the result that very little constructive work has been done.

In studying the effects of radioactivity, both radium and X-rays have been used as a means of experiment, and the literature of both may be considered together on the basis of the current working hypothesis that the effects of both are comparable, especially in the case of the gamma rays of radium. Radium rays are of three kinds, alpha, beta and gamma; of these the gamma rays are the most penetrating, and to them are probably due most of the effects on living forms. From comparative studies of the physicists it is well known that the gamma rays of radium are quite similar in many particulars to the X-rays, and it is stated by Rutherford that they are, in fact, the more penetrating X-rays. Some recent experiments seemed to indicate that the effect of the other rays is by no means negligible, for with the preparation used, when the rays were deflected by a magnet the effect of the beta rays was stronger than that of either of the others. Even in this case, however, the effects seem to differ in degree rather than in the kind of their action, and the results are not in conflict with the hypothesis which is now serving as a working basis for experiment.

In general, it may be said that when living cells are exposed to action of radioactivity, the vital functions are retarded or depressed and a permanent injury may result; this depends on three factors, the strength of the radiating substance, the duration of the exposure, and the distance of the object from the source of the radiation. When the intensity of the radiation is great, owing to exposure at short range to a strong preparation (or strong current in the case of X-rays) for a long time, the effects are much more injurious than when the intensity is less. Indeed, numerous cases have been reported where a qualitative difference results from a slight radiation as contrasted with one of great intensity, for frequently stimuli which will retard growth if of high degree, will be found to accelerate it if weak enough. Exposure to rays of great intensity has been shown to retard or stop growth, differentiation and regeneration, and to interfere with the processes of cell division, sometimes causing degenerative changes to take place in the nuclei, and in one case at least to induce amitosis where indirect cell division had normally been the method of multiplication.

In rapidly growing tissue, such exposure will cause a decrease in the rate of division as well as interfering with its regularity. On the other hand, an exposure of short duration and of slight intensity will in some cases stimulate growth, and accelerate regeneration, and may perhaps cause an increase in the rate of cell division.

The literature[3] on radioactivity and its biological effects is voluminous, but there are only a small number of papers dealing with the question from a biological point of view. There were a very few early papers on the effect on growth and cell division; they, however, were pioneers in this field and their results are not far reaching. Most of the work done at that time, and indeed the majority of all work on the problem, has sought to use radioactivity for the study and solution of questions which were purely medical. Of the early experiments those of Perthes,[4] of Schwarz[5] and of Schaper[6] have perhaps had the most bearing on the later development of the problem. These early investigations were done about 1903–05.

[3] No attempt is here made to offer a comprehensive bibliography on this subject, for such lists are available in Gager, C. Stuart, "Effects of the Rays of Radium on Plants" (*Mem. N. Y. Bot. Garden*, IV., 1908); in Warthin, A. S., "An Experimental Study of the Effects of Röntgen Rays on the Blood-forming Organs with Special Reference to the Treatment of Leukæmia" (*International Clinics*, Vol. 47, 1906); in the publications of Bardeen, of the Hertwigs and others. Only references are here included which bear directly on our present theories for the interpretation of the observed effects.

[4] Perthes, G., "Versuche ueber den Einfluss der Röntgen- und Radiumstrahlen auf Zellteilung," *Deutsche Med. Wochenschr. Jahrg.*, Bd. 30, 1904.

[5] Schwarz, G., "Ueber die Wirkung den Radiumstrahlen; eine physiologische chemische Studie am Huhnerei," *Arch. f. Physiol.*, Bd. 100, 1903.

[6] Schaper, A., "Experimentelle Untersuchung ueber den Einfluss der Radiumstrahlen auf Embryonale und regenerative Vorgänge," *Anat. Anz.*, Bd. 25, 1904.

The pioneer stage of the investigations may be considered to end with Gager, who has been the most important botanist to make contributions to this subject. In his monograph he sums up all of the work that has been done and adds many facts from his own experiments. The work of all these men is representative, and may be regarded as showing the state of progress at that time. The results of each made a distinct contribution to our knowledge of the effects of radioactivity, and are here considered in their chronological order because of their bearing on the subsequent development of the subject.

The work of Schwarz is of importance because from his experiments he erected a hypothesis, the lecithin hypothesis, to explain the destructive effects of radioactivity. His hypothesis "was based on the fact that egg yolk is decomposed by exposure to the radium radiations. Although the matter was not chemically determined, it seemed probable that the lecithin was broken up into cholin and tri-methylamine and other end products of lecithin decomposition. Lecithin has been found by many investigators in all cells, especially in egg yolk, spermatozoa, pollen cells, plant spores, growing buds, and in all rapidly growing tissue. If, then, it is destroyed, such cells must necessarily be unfavorably affected" (Packard). According to Schwarz the effect of radiation on chromosomes and other cell organs is an indirect one where it occurs at all, being brought about as a secondary result of the decomposition set up. It is especially at this point that the lecithin hypothesis comes into conflict with that of Hertwig, to be discussed later.

Perthes' observations were among the first from a biological point of view. He exposed *Ascaris* eggs to radium and noted that the cell divisions became slower than in the controls, where no exposure had been

made. The controls gave rise largely to active worms, but radiated eggs developed only into irregular cell-masses or misshapen little worms which were especially irregular at the tail end, the results depending upon whether stronger or weaker intensity of radiation was used. He says that all three elements which normally take part in mitosis were formed. Centrosomes, spindles and fibers were alike all clear in the experiment and in the controls. The chromosomes divided irregularly, and in *Ascaris megalocephala univalens* the characteristic number was doubled, knotty swellings appearing on the chromatin loops instead of the normal arrangement, and in some places the chromosomes were broken up into numerous unequal pieces. The injury to the eggs expressed itself in the slowing down of the development, which gives rise to abnormal individuals. The results with X-rays were entirely analogous to those with radium, delaying cell division and giving rise to abnormal products of development. In both cases, the chief effects of radiation on the cells appeared indirectly, but only after the lapse of a certain period of time. Eggs in the resting and in the dividing condition served equally well for the experiments.

Schaper exposed frog eggs as well as *Triton* embryos to radium for varying lengths of time. He observed an inhibitory effect on cell division, on embryonic differentiation, and on growth. There was also an inhibition of regeneration which was recognized after a longer or shorter period. The latent period usually lasted almost a day, the duration depending on the intensity of the radiation and on the stage of development of the organism. The period of development was always more or less retarded and prolonged. Finally it reached a standstill and then death resulted. He thinks there is some relation between the manner of solution of the yolk and the effect of the radiation. In older larvæ, the living substances were used up and acute degenerative changes in the cells set in.

Gager[7] reviews the literature on this subject up to 1908 and summarizes the state of knowledge at that time in his last paragraph as follows:

The broadest, and at the same time the most definite generalization warranted by the work so far done is that the rays of radium act as a stimulus to metabolism. If this stimulus ranges between minimum and optimum points, all metabolic activities, whether constructive or destructive, are accelerated, but if the stimulus increases from the optimum toward the maximum point it becomes an over-stimulus, and all metabolic activities are depressed and finally completely inhibited. Beyond a certain point of over-stimulus recovery is impossible, and death results.

His review of the previous investigations he brings together in the following statements:

1. Radium rays have the power to modify the life processes of both plants and animals.
2. Röntgen rays and radium rays produce similar physiological results.
3. Sensitiveness to these rays varies with the species of either plant or animal.
4. Younger, and especially embryonic tissues, are more sensitive than those more mature.
5. With only one or two exceptions, exposure to radium rays has been found to either retard or completely inhibit all cell-activities. The rays may cause irregularities in mitosis.
6. Experimental evidence for or against the existence of a radiotropic response is conflicting.
7. Whatever the immediate, internal change produced in the protoplast may be, the result, with animals as well as with plants, appears to be more or less profoundly modified by the presence of chlorophyll in the cell.
8. Radium rays appear to retard the activity of enzymes.

Since the publication of Gager's results on the effect of radium on plants a large amount of work has been done in the labo-

[7] *Loc. cit.*

ratory of Oskar Hertwig[8] at Berlin. Hertwig himself, his son Günther, and his daughter Paula, and a number of his students have performed an extensive series of experiments over a wide range of forms and have obtained results which are of the greatest significance. In all of their work, radium compounds have been the source of the rays used for experimental purposes. As a strong exposure to radioactivity is always injurious to tissues, and since the development of injured eggs gives rise to malformation and produces monsters of various degrees of deformity, much of the experimental work is teratological in nature. This is interesting from a pathological standpoint, but is perhaps less fundamental than the effects of the radiation on cells (*e. g.*, egg cells) and on their activity. On both these phases of the study the work of the Hertwigs has an important bearing.

The theory which was developed by the early work of the Hertwigs and which has been the working hypothesis upon which their subsequent studies have been made is called by its author a "biological hypothesis." The observation was made in the first cytological studies that centrosomes, spindles and other cell organs with the single exception of the chromatin showed little injury due to the action of the rays. This conclusion was based on evidence from the study of eggs and sperm of sea urchins and of frogs; later the observations have been extended to other forms. It led to the assumption that the effect is a direct one on the chromatin of the radiated cells, not an indirect one as had been postulated by Schwarz, and, further, that the seat of the injury if not exclusively in the chromatin is certainly chiefly there. Due to the fact that a slight radiation of the sperm is sufficient to cause abnormalities in the embryo, it was held that the injured chromatin possesses the property of conveying the injury to the egg cell when it fuses with it and subsequently to the descendants of this cell, for nuclear division provides the mechanism for distributing the injury to all cells of the body. In a sense, therefore, the original injury tends to increase as development proceeds. Hertwig sees in the beta and gamma rays of radium a reagent which affects the nuclear substance of living cells even in the slightest amount. Especially the chromatin is injured in its living properties by the slightest exposure to radio-active rays, and by a greater exposure is so changed that it loses the capacity to grow and to increase in the regular way by mitosis, and undergoes a gradual degeneration into which the cytoplasm is also drawn.

It may be said that this hypothesis has much morphological basis and that it is sufficiently elastic to accord with many of the observed facts; yet it is clear that no real explanation of the phenomena has been offered on this basis, for the problem is simply pushed further back into the cell and it is necessary to make clear how the chromatin is injured and how the injury accumulates with development. It is undoubtedly true also that other substances in the cell than chromatin are injured, although it may not be possible to attribute the irregularities of later development to them, as can be done in the case of the chromatin. A comparison of this hypothesis with the lecithin hypothesis, and criticisms which have been made of each, may be deferred until other facts have been brought out.

Recently Oskar Hertwig[9] has brought together in a brief statement the facts most

[8] A series of papers by O., G., and P. Hertwig, by Oppermann, Fraenkel, and Stachowitz in the *Arch. f. Mikr. Anat.*, Bd. 77 to Bd. 85, 1911–1914.

[9] Hertwig, O., "Versuche an Tritoneiern ueber die Einwirkung bestrahlter Samenfäden auf die tierische Entwicklung," *Arch. f. Mikr. Anat.*, Bd. 82, Abt. II., 1913.

important from his interpretation which have been obtained as the results of the investigations in his laboratory. The following facts are emphasized by him:

1. Fertilized *Ascaris* eggs, which had been radiated several hours showed pathological nuclear division figures in which the chromatin bodies are represented by irregular masses of chromatin granules. They divide slowly and begin at last to degenerate by caryolysis. (Paul Hertwig.)

2. By intensive radiation of several hours' duration, sperm threads of the sea-urchin are so affected that, while they are able to fertilize the egg and to stimulate the egg nucleus into spindle formation, they lose their ability to form normal chromosomes and thus are eliminated from development partially or completely, sooner or later, depending on the degree of the injury. (Günther Hertwig.)

3. An elimination of the sperm nucleus which is derived from intensively radiated sperm threads has been observed during the first and second divisions in eggs of the frog (Paula Hertwig) and of the trout (Oppermann).

4. For the elimination from the development process of the radiated sperm chromatin which has lost its capacity to develop, the fact established beyond doubt for the radiated larvæ of *Triton* speaks convincingly, that the somatic nuclei have only half, or the reduced, number of chromosomes. Since the male chromosome complex fails to take its part in the development, due to the radiation, the somatic nuclei have only the female complex. (Oskar Hertwig.)

5. This fact agrees with the result obtained for frog, toad, *Triton* and trout embryos, that after the maximum radiation of the sperm which are to be used for fertilization, the nuclei of the different cells are strikingly smaller than are those of the controls of the same age, and both their surfaces and their volumes are in ratio to those of the control as 1:2. For the conclusion, that the chromosome number of the nucleus is the haploid, may be drawn from the fact established by numerous experiments that the volumes are reduced almost to half. (Oskar Hertwig, Günther Hertwig, Oppermann.)

6. The results obtained from cytological investigation offer the possibility of explaining a fact highly remarkable from a physiological standpoint and at first glance a very puzzling one, that eggs, which would ordinarily fail to develop from the germinal vesicle stage when fertilized by foreign sperm because of the union between disharmonious idioplasms, are spared from destruction and may develop into larvæ if only the sperm from the different species are radiated intensively before fertilization. The puzzle is solved by the simple reflection that the effect of the union of the disharmonious idioplasms with its disastrous consequences is avoided by the injury to the radiated chromatin, although the sperm thread penetrates into the egg and stimulates development. Although the radiation of the strange sperm has been destructive to the sperm, it has been favorable to the fertilized egg, just as in the living body a poison substance is counteracted by another poison.

The investigation of radiation effects on *Ascaris* eggs was undertaken by Fraülein Paula Hertwig in order to obtain definite evidence on the facts at the basis of the biological hypothesis. Her conclusion is that the division of the eggs is retarded, and pathological appearances are very soon noticeable after the radiation; chromatin is strongly affected, as already stated, although the centrosomes, spindles and other cell organs show no injury; unfavorable action of the cytoplasm is not to be assumed since no change can be seen. She is able to

find no ground for the lecithin theory, but interprets her facts from the contrary viewpoint. The effect of radium upon *Ascaris* eggs has been reinvestigated by Payne[10] who confirms the results just given.

Günther Hertwig, following the lead of his father, in his various studies set up four series of experiments, the A, B, C and D series. In the A series, eggs were radiated in the two-cell stage, or after fertilization; in the B series, sperm were radiated and then used to fertilize normal eggs; in the C series, eggs were radiated and then fertilized by normal sperm; in the D series, both eggs and sperm were radiated before fertilization. The experiments described in his first paper were on the frog's egg. He found that in the C series (normal sperm by radiated eggs) the injury increases with the duration of the radiation up to a maximum, and from there on decreases again as the radiation is prolonged. Only the radiated nuclei show the effects, and there is no evidence for the hypothesis that yolk which contains lecithin is being broken down. The injury is greatest on young tissue and on tissues which are to be highly specialized; it is productive of manifold disturbances of the developmental processes. In the frog development is possible with only a haploid nucleus, that is, only the half of the nucleus derived from one parent. Where the injury is severe to either the egg or sperm nucleus, the other is able to carry on the development, and in fact there is less interference with the regular course than in the case where both nuclei are injured slightly and both take part in the process, for here the injured half is no longer a factor; it is able only to stimulate development and then is eliminated from the process. In other words from the standpoint of heredity, this is a case of parthenogenesis. For the spermatozoon always has two functions to perform: it must initiate development, and it must carry the inheritance from the male line. In this case only the first function is accomplished, and parthenogenesis is the virtual result, the male pronucleus being eliminated from development by failing to unite with the female pronucleus. This result is important as evidence that the nucleus is the bearer of the inheritance substance and that in the beginning of development male and female nuclei are of equal significance.

Subsequently Günther Hertwig performed a similar set of experiments on the eggs of the sea urchin. Here he was able to work out the cytological details of the process and to establish firmly his view just stated, that the eggs after intense radiation really undergo parthenogenetic development. This is the most important point of his contribution, although he presents much evidence for the biological hypothesis.

A great many other experiments have been carried on in Hertwig's laboratory at Berlin, and all of them contribute to the same conclusions. The principles already discussed are the most important ones brought out, and they are supported by a large amount of evidence; many data also have been gathered from these experiments which are valuable from the standpoint of teratology. This, of course, is incidental to the evidence for the biological hypothesis.

In America, although much attention has been given to the medical aspects of radioactivity, very little work on the biological phases of the problem has been attempted. Bardeen[11] has carried out systematic ex-

10 Payne, F., "A Study of the Effects of Radium upon the Eggs of *Ascaris megalocephala univalens*," *Roux Archiv.*, XXXVI., 1913.

11 Bardeen, C. R., "Abnormal Development of Toad Ova Fertilized by Spermatozoa Exposed to Röntgen Rays," *Jour. Exp. Zool.*, IV., 1908. "Variations in Susceptibility of Amphibian Ova to the X-rays at Different Stages of Development," *Anat. Record*, III., 1909. "Further Stud-

periments of the toad's and frog's eggs, demonstrating that abnormal embryos result from radiation, and showing to a certain extent under what conditions they are produced. The kinds of abnormalities are described and experiments given to determine the periods of greatest susceptibility. The following are among his most important conclusions:

> These experiments show conclusively that both the male and the female sex-cells may be so altered by the X-rays as to give rise to the formation of monstrous forms. The susceptibility of the male and female sex-cells is approximately equal, although the abnormalities appear earlier in development and are greater when the ova are exposed. After fertilization until cleavage begins, the ova at first appear to be no more susceptible than the sex-cells before fertilization. During the earlier stages of cleavage the susceptibility of the eggs to the X-rays is markedly increased, but during the later stages of cleavage before closure of the blastopore the susceptibility of the eggs becomes much less, and after the blastopore is closed the power of the X-rays to influence development becomes strikingly reduced. The period of greatest susceptibility is the period during which there is the most rapid production of nuclear material.

Packard[12] has recently published an account of his experiments on the effect of radium on the fertilization of *Nereis*. These experiments were performed to ascertain how "early the development of the egg is affected by radium radiations when (1) the sperm is exposed; (2) when the egg is exposed; and (3) when the egg is exposed immediately after fertilization." His results are important, for he finds that, in addition to the usual effects such as retardation of development, multipolar spindles and the like, not only chromatin, but also the achromatic portions of the spindles and the cytoplasm, show the effects of the exposure. In eggs radiated before fertilization, it may happen that the alveolar layer of the cytoplasm is not extruded as is normally the case in the eggs of *Nereis*. If this occurs the maturation processes are much modified, resulting in diverse forms of chromosomes and spindles, with perhaps small asters scattered about through the cytoplasm; and various other irregularities may be present in the mitotic figures. Thus it will be seen that Packard's observations do not all agree with those made in Hertwig's laboratory. Parthenogenesis is not found to occur in *Nereis* as the result of exposure to radium, but it is a common observation that the eggs of that animal are not as favorable for parthenogenetic development as are those of the sea urchin upon which Hertwig worked.

For various reasons the hypotheses of both Hertwig and Schwarz are held to be insufficient to account for the phenomena observed by Packard, and he proposes another explanation, suggesting "that the radium radiations act indirectly on the chromatin and protoplasm by activating autolytic enzymes which bring about a degeneration of the complex proteids, and probably by affecting other protoplasmic processes in the same manner." This hypothesis is reached partly as a result of his own experiments and partly from a consideration of certain other work, and to some extent takes a middle ground between the other two, although in some phases it differs sharply from both. Cells contain a great many kinds of enzymes and it has been shown by a number of investigators that radium rays and X-rays have the property of modifying the action of some enzymes. Packard concludes that while many enzymes may be activated, "the lytic enzymes are more stimulated than those which play a synthesizing rôle." Where a

ies on the Variation in Susceptibility of Amphibian Ova to the X-rays at Different Stages of Development," *Amer. Jour. Anat.*, Vol. 11, 1911.

[12] Packard, Charles, "The Effect of Radium Radiations on the Fertilization of *Nereis*," *Jour. Exp. Zool.*, 16, 1914.

slight radiation results in acceleration, the synthetic processes may be supposed to be stimulated more than the destructive activities. This hypothesis is essentially chemical in nature and seeks to explain the morphological effects observed in the cells as the indirect result of enzymotic activity under the influence of the radiation.

Various new arguments for and against these hypotheses and theories have been brought out as new facts have developed. It is, therefore, necessary to consider the more important points critically.

The lecithin hypothesis was established on the basis of an experiment by Schwarz, showing that in the chicken egg yolk, containing lecithin, is broken down under the influence of radium. Against this hypothesis numerous objections are now to be raised. Hertwig pointed out that the decomposition was not determined by strict chemical methods, and Neuberg also criticizes it on chemical grounds, for lecithin is itself so unstable that only a very accurate chemical study could determine whether its decomposition was actually due to the radium radiation.

If the seat of the injury were in the yolk, little effect could follow radiation of the sperm before fertilization, for the sperm at most contains but little lecithin, and contrarily, much greater injury should result when the egg is radiated. As a matter of fact, there is very little difference between the results on the embryo, whether it is the egg or the sperm that is radiated before the fertilization. Egg nuclei are equally capable, with those of the sperm, of contributing the chromatin by which the parthenogenetic development previously described takes place, both at first are able to start the development of the egg so far as the hereditary units are concerned, and injuries arising from the disturbance of either are equally great.

Very little lecithin could be decomposed when so short a radiation of the sperm as a minute was employed, as by G. Hertwig; yet this radiation was sufficient to cause marked departures from the normal in the embryo. That no chemical poison is generated by lecithin decomposition is obvious, for in the case of the short radiation of the sperm the poison would be too dilute to cause effects equal to those resulting from longer radiation of the egg.

The lecithin theory takes no consideration of the fact that the most careful cytological study shows no morphological evidence of yolk destruction; nor of the fact that nuclei and especially chromatin do suffer marked changes as the results of the radiation. On the latter point all investigators agree, and it must be explained by any hypothesis which seeks to account for the changes produced. Furthermore, yet other cell constituents are acted on by radiation, for cell extracts and cell enzymes have been shown to be activated or retarded in their action, depending upon the conditions of the experiment.

In this connection, it is by no means clear how lecithin decomposition within the egg could prevent, as Packard found radiation to do, the extrusion of the alveolar layer of the cytoplasm, a phenomenon depending upon activities at the surface of the egg. And finally, it is not possible to account on this basis for the elimination of the sperm head from development, or for the fact that somatic nuclei of radiated *Triton* embryos contain only half or the reduced number of chromosomes.

Most of these arguments against the lecithin hypothesis were, of course, unknown at the time it was proposed. They are so much at variance with it, however, that it seems impossible to give it further serious consideration. It may be regarded as completely overthrown.

Similar explanations have been suggested by others, *e. g.*, by Hippel and Pagenstrecher[13] who find that x-radiation of rabbits produces an effect similar to that resulting from cholin injection and think that a toxin is developed which is transferred from mother to embryo, to the injury of the latter. The facts already brought out here show that this explanation is not a sufficient one, nor one of general application.

The objections to Hertwig's biological hypothesis are less serious than in the case just discussed, and they would scarcely hold against it in a less extreme form. It is, of course, true that the solution offered by Hertwig is incomplete in that it does not go far enough back into the organization of the cell; for, even on the assumption that the chromatin is the chief seat of injury, further explanation, which must ultimately be chemical in nature, is required to show how the injury is communicated to other parts of the cell and what the mechanism is by which its action is manifested.

According to the Hertwig hypothesis, chromatin above everything else in the cell suffers injury from radiation and the pathological conditions in the embryo are traceable to the injured chromatin, which may be regarded as a "contagium vivo" increasing, ferment-like, at each division.[14] Thus the mechanism of the cell provides the means for distributing the injury to each successive cell generation and for carrying it to all parts of the embryo.

To this theory, Packard has offered two criticisms. The concept, that the injured chromatin or a substance produced from it acts as a contagium vivo, is scarcely a solution of the problem, for it merely restates in another form certain facts observed and presents a picture of the problem itself from a different viewpoint without giving any explanation of the facts. It should again be pointed out that the ultimate solution must be chemical in nature. Packard also questions the assumption that the injurious substances developed in the nucleus must remain there and can not involve purely cytoplasmic structures even during division (for a normal haploid division of the egg chromosomes takes place if the radiated sperm head does not mechanically interfere in the spindle). A condition contrary to this assumption is given by Packard, showing that cytoplasmic structures are changed in *Nereis* eggs, for example in the case of eggs radiated before fertilization which fail to give off the alveolar layer and thus extrude the jelly as they should do. Obviously here the injury has been communicated to the egg cytoplasm, and is not in accord with the Hertwig assumption.

But the most serious objection to the Hertwig theory as it now stands lies in the fact that other than nuclear structures and substances are affected by X-rays and the radium rays. The failure to extrude the alveolar layer in *Nereis* eggs is a case in point, and in the same eggs abnormal spindles and asters occur as a consequence of radiation. It has been found by numerous investigators that radium rays have the power to affect enzymes, and the writer[15] has shown that X-rays are able to bring about modification in the activity of certain enzymes. Enzymes are derived from living tissues, and if it is possible to cause their modification outside of the cell by the use of radioactivity it is not improbable that they also undergo change while within the cells. In fact, the writer working with Miss Woodward[16] was able to prove that X-rays

13 *Münchner Med. Wochenschr.*, No. 10, 1907.

14 Hertwig, O., "Die Radiumkrankheit tierischer Keimzellen," *Arch. f. Mikr. Anat.*, Bd. 77.

15 Richards, A., "The Effect of X-rays on the Action of Certain Enzymes," *Amer. Jour. Physiol.*, Vol. 35, 1914.

16 Richards, A., and Woodward, A. E., "Note on the Effect of X-radiation on Fertilizin," *Biol. Bull.*, V., 28, 1915.

can be used to influence the activity of the cell extractive called fertilizin. This substance is extracted from sea-urchin and starfish eggs when the ripe eggs are allowed to stand in water for a short time, and it possesses the property of causing the agglutination of the sperm of its own species. Its behavior is in some respects comparable to that of an enzyme and it is possible that the substance contains enzymotic bodies. The experiments showed that radiation by X-rays is capable of changing the activity of fertilizin, and in general agrees with previous work that weak radiation is accelerative and strong inhibitive. Fertilizin is a substance derived from the living eggs and the extraction takes place while the egg is in the resting stage, sometimes even in the germinal vesicle stage; at this stage chromatin can scarcely play any part in the giving off of fertilizin. In this case, then, the radiation has had a considerable, and a measurable, effect on a cell substance independent of the chromatin or other nuclear structures. This fact can hardly be brought in line with the Hertwig hypothesis in its present form.

Yet it is true that chromatin and nuclear structures are greatly changed by radiation. In any true explanation that may be given this important fact must be dealt with. It is possible that a modification of the present form of the Hertwig theory in which the effect on enzymes is recognized may be sufficient to account for all the facts that are now known.

Packard has attempted such a modification in his suggestion "that the radium radiations act indirectly on the chromatin and protoplasm by activating autolytic enzymes which bring about a degeneration of the complex proteids, and probably by affecting other protoplasmic substances in the same manner." Against this hypothesis there is little that can be urged except the fact that it rests upon insecure evidence, there being but few actual observations or experiments which contribute to it. It is certain that radiation influences the activity of various enzymes, but there is very little evidence upon which to base the assumption necessary to the hypothesis that those enzymes which cause katabolic changes in the cell proteids are accelerated to a greater extent than those which have the opposite function. For this reason judgment can only be suspended until such a time shall come when accurate and more abundant data are at hand for attacking the problem.

Joly[17] has proposed a different kind of explanation to account for x-ray effects. Comparing the events which take place in a photographic film with those which occur in cells subjected to gamma or to x-rays, he supposes that the rays increase ionization in the tissue. The various results found are accounted for as due to differing degrees of ionization and to the presence or absence of an "intensifier" or an "inhibitor." No evidence from biological studies is given to support this hypothesis, however; it must, therefore, await experimental confirmation.

It will be seen from the foregoing review that all the investigations which have contributed to the development of these various theories either have had a morphological basis or were of a chemical nature. Along these lines there remains a great deal to be accomplished; we especially need more exact information on the nature of the injury which is done to the chromatin and to the cell organs.

But in addition to the morphological study the general problem must be studied by other methods. The question is raised as to what is the nature of the stimulus by

[17] Joly, J., "A Theory of the Action of Rays on Growing Cells," *Proc. Roy. Soc.*, Series B, Vol. 88, 1914.

which radioactivity affects organisms. According to Verworn a stimulus is "any change in the external agencies that act upon an organism." Are the rays of radium or X-rays comparable to the electric current, for example, in the manner in which they affect protoplasm? An experiment was performed by the writer to gain information on this point. A frog's leg was set up as a muscle-nerve preparation; when stimulated electrically it was found to react normally. The nerve, and later the muscle directly, were exposed to X-rays. When the brush discharge was carefully screened away from the preparation, the X-rays were unable to cause any contraction, even of the slightest extent, as shown on the drum of kymograph. This result was obtained repeatedly. While it gives no information as to real nature of the stimulus, it indicates that the stimulus of radioactivity is not comparable in its effects with that of the electric current.

Gager has adapted Verworn's biogen hypothesis to explain the manner in which radium rays act as a stimulus to organisms, and to provide the mechanism by which the stimulation may be supposed to operate. A stimulus is any change in the external agencies that act upon an organism. Metabolism according to Verworn "depends upon the continual destruction and continual reconstruction of a very labile chemical compound," biogen, which "develops at an intermediate point in metabolism, and by its construction and destruction comprehends the sum total of metabolism." It is not a protein nor living, for a molecule can not be alive. The ratio of construction and destruction of biogen molecules under normal conditions of equilibrium is $\frac{\text{construction}}{\text{destruction}} = 1$. Therefore, "the irritability of living substance depends upon the lability of the biogen molecules.

Now, Gager remarks:

Both the dissimilatory and the assimilatory phases of metabolism may be stimulated. The degree of dissimilatory stimulation is, for equally intense stimuli, dependent upon the following factors:

(a) The degree of lability of the biogen molecule.
(b) The rapidity of the process of restitution after the functional destruction of the biogen.
(c) The absolute number of biogen molecules present.
(d) The conditions of the propagation of the stimulation.

A dissimilatory stimulation, or depression, may be brought about by influencing any one of these individual factors. On the other hand, the degree of assimilatory irritability is dependent upon:

(a) The quality of the raw material available for nutrition.
(b) The means for working up the raw material into a suitable form of elaborated matter.
(c) The quantity of suitable elaborated matter.
(d) The rapidity of the transformation of the elaborated matter from the reserve depots into the biogen molecules.

An assimilatory irritability or depression may arise through influencing each of these individual conditions.

Radium rays, by acting on any one of the eight factors enumerated above, may, therefore, excite or depress processes of either assimilation or dissimilation.

Further, Gager points out the probability that radium rays may not affect their stimulation "by acting directly upon the biogen molecules, or whatever the reality may be that corresponds to this term, but by acting upon other substances in the individual cells, or by modifying some process either preceding or following the elaboration of the biogen molecule." The rays may produce their effect indirectly by acting upon some non-vital constituent other than the biogen, or upon some purely chemical process. Thus does he conceive the mechanism by which the rays produce the changes which they effect on organic bodies.

It will be seen that this elaborate conception of the method by which the results

are produced does not in any way conflict with the hypotheses already stated but is really an accessory to them. Although Gager probably had no such thought in mind, his conception is in complete accord with a theory of enzyme modifiability, which at the same time presents a picture of the manner in which the radiations affect protoplasm.

Early in the investigations the question arose as to whether the effects observed in the division of the egg might not be due to a change caused by the radiation in the permeability of the cell membranes to certain substances contained in the solution in which the eggs developed. It is known that surface changes due to the alteration of permeability account for many of the phenomena connected with the initiation of development and cell division, and by analogy it was argued that to similar changes might be due the retardation of division rate as well as other departures from normal as they occur in the radiated eggs. To test this question the writer undertook a series of experiments[18] in which several different tests for permeability change were used and all gave the same result: that the X-ray effects are not to be attributed to permeability changes caused by the radiation. In the first method, the larvæ of *Arenicola*, a marine worm, were employed, for it had been found that, when these larvæ are brought into any solution that causes permeability changes, a yellow pigment is exuded from the integument; no exudation could be observed under the influence of the radiation. The second method consisted of experiments conducted with the view to producing artificial parthenogenesis, for upon the basis of the current working hypothesis, artificial parthenogenesis is due to the cytolysis of the cortical layer of the protoplasm, which in its turn is correlated with permeability changes on the egg membrane; positive results from experiments to cause this phenomenon would therefore imply permeability changes. The experiments were unsuccessful in the attempt to cause parthenogenesis. Various modifications of the indicator method were used, all with the result that substances in solution were found to enter the cell, which had been stained with some neutral indicator, in this case neutral red, after exactly the same interval in both the radiated and the unradiated control cells. This shows that the radiation is ineffective in causing permeability changes in the cell membranes. These experiments warrant the conclusion that permeability changes are not the causal factors in the events which follow radiation.

From Gager's conclusions that radioactivity is a stimulus to metabolic processes, it may be inferred that the functions, as cell division, which even remotely depend on these processes would also be affected by radiation. Such an inference is borne out by the observations[19] made by the writer on the rate of division in *Planorbis* eggs that had been exposed to X-rays, for in these experiments it was found that a light radiation served to accelerate the first one or two mitotic cycles that followed it; after that injurious effects gradually asserted themselves. A strong radiation was directly inhibitive. The cytological study of the eggs used in these experiments has not been completed, so that it is as yet impossible to correlate the observations on the living eggs with changes in the finer details of their structure. It is of course possible that we have manifested in these physiological

18 Richards, A., "Experiments on X-radiation as the Cause of Permeability Changes," *Amer. Jour. Physiol.*, Vol. 36, 1915.

19 Richards, A., "The Effect of X-rays on the Rate of Cell Division in the Early Cleavage of *Planorbis*," *Biol. Bull.*, Vol. 27, 1914.

processes influences that make no impress on the morphological structure of the egg.

The case of the influence of X-rays on fertilizin, already referred to, provides another instance where the effects are without direct morphological representation. Doubtless others occur. These cases must of course be accounted for by any explanation of the effect of radiation on living organisms.

The facts, as they are at present known in regard to the effects of radioactivity on living matter, show that life processes are subject to marked changes under the influence of the radiation, a slight exposure being accelerative in most cases, while a more intense treatment is inhibitive or destructive. As a causal factor in these effects, the demonstrable injury to the chromatin of the cells is undoubtedly important; but there are also good evidences that the modifiability of enzymes under the action of the rays likewise plays a considerable part either directly or indirectly in the resulting injury.

A. Richards

Woods Hole

ARE RECESSIVE CHARACTERS DUE TO LOSS?

Since the presence-absence theory came into vogue it has become quite customary to regard recessive characters as due to the absence of something in the germ plasm on which the corresponding dominant character depends. The nomenclature of the presence-absence theory has been adopted by most writers on Mendelian inheritance, and it has afforded a useful and convenient method of expressing gametic formulas, although, as Morgan has shown, there are cases in which it leads to inconsistent results. While it is often recognized that this nomenclature is a purely symbolic scheme of indicating how certain characters behave in inheritance, the habitual employment of the system in the search for formulas which will designate by a series of large and small letters the gametic constitution of the organisms one is dealing with, has a strong tendency to influence one's views in regard to several important problems of heredity and evolution. I can not but think that the opinions of many students of genetics have been unduly influenced by their formulas. Formulas are excellent servants but bad masters. Almost involuntarily a certain interpretation is attached to their symbolism which is apt to have the practical effect of actual belief if it does not succeed in producing it.

Since the establishment of Mendel's law and its successful employment in elucidating many previously enigmatical phenomena of inheritance, heritable variations have commonly come to be considered as due to the addition or subtraction of discrete units of germ plasm, the bearers of unit characters. Professor Bateson in his "Problems of Genetics" says in regard to substantive variations that

> we are beginning to know in what such variations consist. These changes must occur either by the addition or loss of factors.

And further on he makes the following significant statement:

> Recognition of the distinction between dominant and recessive characters has, it must be conceded, created a very serious obstacle in the way of any rational and concrete theory of evolution. While variations of all kinds could be regarded as manifestations of some mysterious instability of organisms this difficulty did not occur to the minds of evolutionists. To most of those who have taken part in genetic analysis it has become a permanent and continual obsession. With regard to the origin of recessive variations, there is, as we have seen, no special difficulty. They are negative and are due to absences, but as soon as it is understood that dominants are caused by an addition we are completely at a loss to account for their origin, for we can not surmise any source from which they have been derived.

In his more recent address before the British Association, Bateson not only interprets all recessive characters as due to loss, but suggests that dominant characters may have arisen by the removal of inhibiting factors, thereby causing a "release" of the characters which previously lay latent in the germ plasm,

and producing the appearance (but only the appearance) of new variations. He says:

> In spite of seeming perversity we have to admit that there is no evolutionary change which in the present state of our knowledge we can positively declare to be not due to loss.

If we explain not only the actual disappearance of characters as caused by germinal loss, but the appearance of new characters as due to the loss of inhibitors which prevented these characters from manifesting themselves, it is theoretically possible to consider the whole process of progressive evolution as accomplished by the sloughing off of inhibiting factors. Such a doctrine which naturally reminds one of the extravagancies of the theory of emboitement might have proved quite acceptable to Leibnitz, Haller, or Bonnet, but, unless I misunderstand him, Professor Bateson has presented this view more as an illustration of the bankruptcy of present evolutionary theory than as a matter of serious conviction of his own. I will not discuss this interesting speculation further than to observe that any interpretation of variation which logically leads to such a standpoint naturally incurs a very justifiable suspicion of unsoundness. It may be that in the case of any particular variation we are unable to positively declare that it is not due to loss, but on the other hand we are unable to positively declare that most variations *are* due to loss. I think I am not going too far in stating that a germinal variation due to loss has not been proved to occur in any single case. If it is legitimate to explain the appearance of new characters as due to the removal of inhibitors, we may also explain the apparent loss of a character as due to the advent of inhibitors. It is surely justifiable to assume that inhibitors can come into an organism somehow if we are permitted to make such frequent use of their disappearance in accounting for the origin of new variations. The plain fact is that we know practically nothing of the changes in the germ plasm which we postulate as the causes of variability. It is easy to assume the existence of an inhibitor to bring any particular variation into line with one's general theory, but such explanations are purely formal and therefore of little scientific value.

While few would be inclined to follow Bateson in his rather paradoxical interpretation of dominance, the doctrine that recessiveness is due to loss is coming to be quite prevalent among workers in genetics. One of the chief reasons for regarding so much of the variation that has arisen among domestic animals as caused by the loss of factors is the fact that the crossing of different varieties often produces a reversion toward the ancestral type. If we regard the ancestor of our races of domestic mice for instance as possessing a full complement of factors, and assume that the different varieties have arisen by the dropping out of one or more factors in this variety, and one or more other factors in that variety, then when these varieties are crossed the hybrid may possess all the factors of the original ancestor and hence show a reversion to type. On the basis of this assumption one can make out gametic formulas for the different varieties of a species, test them by breeding experiments, and thus verify their correctness. Gametic fomulas obtained in this way doubtless symbolize a truth in regard to the germinal constitution of the organisms in question. The value of such formulas is no longer a matter of doubt, and is quite independent of the various interpretations that can be made concerning the nature of the symbolism, just as chemical formulæ are of value quite irrespective of the various theories of the constitution of atoms.

Consider the origin of a black mouse according to the presence-absence hypothesis. We may explain the origin of a black mouse by saying that it is caused by the absence of the agouti or ticking factor that breaks up the color of the hair into bars. Gray is therefore black plus an agouti factor. But does it follow that because we can interpret the facts in this way, and interpret them consistently so far as breeding experiments are concerned, the change that has taken place in the germ plasm that produced a black mouse was really a loss? Such a change is frequently

assumed to be the result of an actual loss of a little discrete unit of some sort in the germ plasm. De Vries has interpreted recessiveness as due to the latency or loss of potency of pangens, but we may also assume that the germinal basis of the character in question has undergone a change of such a character that without becoming inactive it ceases to function in its usual way. The agouti factor (commonly designated by G) may be regarded as dependent on a part of the germ plasm, a section of a chromosome possibly, which when present causes the barring of color in the hair. When a black mouse arises we may suppose that something takes place in G. It is not necessarily a change in the direction of either chemical or organic simplicity any more than it is necessarily a loss of substance. The fact that the modified condition is recessive to G proves nothing whatsoever in regard to the nature of the transformation that has occurred in the germ plasm. Assuming that G is not actually lost, but modified into another kind of substance g, the recessiveness of g may be due to the fact that its activity is manifested in a different way, relative slowness of its metabolism, or to various other conceivable causes.

There is, I believe, no good reason for considering the recessiveness of a character as due to the relative simplicity of its germinal basis. Many variations of a minus character are recessive, but there are numerous exceptions to this rule, as is illustrated by the dominance of the hornless condition in cattle, the short tail of Manx cats, and the lack of beards in certain kinds of wheat. Suppose we have two allelomorphic units (assuming for the present that there are such things as germinal units) A and A′, one of which tends to produce a relatively simple development of a part and the other a relatively complex development of a particular part of the body. The one A calls forth, say, simple horns, the other branched horns. A and A′ presumably differ chemically, and the development of the part in question depends not upon A or A′ alone, but upon how these agencies affect other parts of the body during development. Will the simpler substance or organic unit call forth the simpler structure in the adult body? Inasmuch as the development of any organ involves activities in which a larger number of elements are concerned it seems not at all improbable that the simpler substance or unit might conspire to produce the more complex organ. Now suppose that the forked horn proved to be dominant over the simple horn. What conclusions would we be entitled to draw from this fact concerning the germinal basis of these characters? Obviously none.

Whether we interpret a variation as a gain or a loss is in most cases a purely arbitrary matter. In sugar corn there is a loss of starch but there is a gain of sugar. Does sugar corn therefore represent a plus or a minus variation? Consider the familiar cases of rose comb and pea comb in poultry. Both of these variations are dominant over the primitive condition of single comb. Yet both breeds carry the basis for the production of single comb in their germ plasm. It is commonly assumed that both conditions represent single comb plus something. We may suppose that in a certain chromosome a change has taken place which results in the development of rose comb. This change, for all that we know, may be due to the loss or impairment of a portion of germ plasm, or it may be due to a change not properly describable as either a gain or loss. We may regard rose and pea comb as more or less pathological deviations based on germinal defect, as true progressive variations, or simply as normal variations neither progressive nor retrogressive. So far as complexity of structure is concerned it may be a matter of dispute whether rose comb, pea comb, or single comb represents the higher grade of development.

But, it may be asked, are not color varieties commonly due to loss, and is not this obviously the case with albinism? In many varieties there has certainly been a loss of pigment, but has there been a dropping out of factors? It by no means follows. The factors represented by small letters in our color formulas are by no means missing entities. They are changed so that they occasion a diminished production

of certain pigments, but in other respects they may be as potent as before. The albino does not produce pigment, but there may be other substances in the place of pigment that would distinguish the albino as a positive variation when judged by other standards. The animals whose gametic formulas contain a number of small letters are not necessarily more imperfect or perhaps I should say incomplete than their congeners which carry a large number of dominant characters.

Of course there may be varieties due to losses of germinal material. Considering the complex mechanism of mitosis, and the opportunities afforded for the loss of chromatin during this process, such variations are not improbable *a priori*. But there is not the slightest warrant in the fact of recessiveness *per se* for the doctrine that all recessive variations are produced by this method. The origin of so-called unit characters may depend, for the most part, not upon germinal loss or gain, but simply on transformation. Viewed in this simple and natural way the appearance of a new dominant character is not an event to be marvelled at. Dominant and recessive characters not improbably owe their origin to much the same causes. At least we do not know that they do not. Concerning the real causes of variations of any kind we know very little more than we did when Darwin commented on our profound ignorance of this subject. It is therefore premature to pin our faith to any particular theory of the origin of variation and especially to draw far-reaching conclusions regarding evolution on the basis of such an interpretation. We may conceive variability as due to germinal losses or gains for the sake of our formulas, and there may be little harm in so doing so long as it is clearly realized that the procedure is a purely arbitrary and schematic method of recording certain facts of inheritance. But when we make the serious attempt to apply the conception to what actually takes place in the germ plasm we encounter a fruitful source of fallacies.

S. J. HOLMES

UNIVERSITY OF CALIFORNIA

ERNST GRIMSEHL[1]

ON October 30, 1914, Ernst Grimsehl fell near Langemarck in the bitter fighting along the Yser line. Only two days before he had received the iron cross. Although he was in his fifty-fourth year, yet he responded voluntarily and full of enthusiasm to the call to the colors as an "Oberleutnant der Landwehr." On October 1 he marched with the 213th regiment across the Belgian frontier. For only a few weeks was he permitted to fight for his country which he so dearly loved. He died, as so many others at his side, without living to see the victory which he so confidently hoped for.

In his death the German educational system loses a personality which was unique in its character and therefore can not be replaced. All his thoughts and efforts were directed to this ideal of placing physics teaching on a firmer basis and of bringing it nearer and nearer to perfection. His friend, A. Keferstein, has in the *Unterrichtsflättern* sketched the character of his work with beauty and conviction. He says in part:

> His preeminent manual dexterity and his thorough knowledge of the instrument-maker's art, which as a student he had gained in his vacation days from the masters of the art, qualified him for the creation of clean-cut models of apparatus. These he tried out at every point till he had corrected by his masterly hand their first faults and made them respond to his every wish.

Of his original inventive skill as an experimenter, numerous publications bear witness; one must have watched him getting ready for an experimental lecture such as he was wont to give almost every year at the spring meeting of the Association for the Promotion of Instruction in Mathematics and the Natural Sciences, in order to gain the secret of this skill. He was tireless and enthusiastic in his efforts to perfect his arrangements, often by hours of labor in a strange place and in a

[1] Translated from *Zeitschrift für den Physikalischen und Chemischen Unterricht*, January, 1915, and read at the seventieth meeting of the Eastern Association of Physics Teachers by N. Henry Black.

strange laboratory, so that he might manage things there just as in his own rooms. Everything must be carefully tested before he began his lecture. So it came about that his demonstrations became the star performances and attractions of each of these meetings.

It is difficult to enumerate all the pieces of apparatus for purposes of instruction and investigation which we owe to him. These are almost all published in our magazine, in which he took a lasting interest. Even the first volume in 1888 contained a report of his paper in which he published a new method of measuring the intensity of a tone. In the second volume there appeared the first original investigation from his hand, in which he described two pieces of apparatus for detecting the nodal points and internodes in a sounding column of air. His last lecture, which he gave in the spring of 1914 upon a new and simple means of showing the interference of light, he had also intended for our magazine. However, before he came to write it down, the war had pressed into his hand the sword instead of the pen.

Of his books only two may be mentioned here: the large "Lehrbuch der Physik"[2] which has in five years gone through three editions and the "Didaktik und Methodik der Physik"[3] (a part of Baumeister's Handbook) which in spite of its brevity and its strong personal color, is rich in valuable advice and fruitful ideas.

Death has brought his work to an untimely end, but the influence of this creative work will live after him and will assure for him a grateful memory among his followers as well as in the history of the teaching of physics.

SCIENTIFIC NOTES AND NEWS

Dr. Paul Ehrlich, the distinguished German pathologist, director of the Royal Institute for Experimental Therapeutics in Frankfurt a. Main, died on August 20, at the age of sixty-one years.

[2] B. G. Teubner, Leipzig.

[3] C. H. Beck'sche "Verlagsbuchhandlung," München.

Dr. Carlos J. Finlay, a leading physician of Cuba, known for his advocacy of the theory that yellow fever is transmitted by mosquitoes, died on August 20, at the age of eighty-two years.

It is announced that in consequence of the war, the meeting of the Australasian Association for the Advancement of Science, which had been arranged to take place in Hobart in January next, has been postponed for a year.

Dr. David Bancroft Johnson, president of Winthrop Normal and Industrial College, of Rockhill, S. C., has been elected president of the National Education Association, in succession to Dr. David Starr Jordan, chancellor of Stanford University.

During the San Francisco meetings of the American Association for the Advancement of Science, there was formed a Pacific Coast Branch of the American Society of Zoologists. The officers elected at this meeting were:

President: V. L. Kellogg, Stanford University.

Vice-president: R. M. Yerkes, Santa Barbara.

Secretary and Treasurer: Joseph Grinnell, University of California.

Executive Committee: C. O. Esterly, Occidental College; Barton W. Evermann, California Academy of Sciences; Charles L. Edwards, Los Angeles; J. Frank Daniel, University of California; Harold Heath, Stanford University.

At the same meeting there was formed a Pacific Coast Branch of the American Society of Naturalists with the following organization:

President: Barton W. Evermann, California Academy of Sciences.

Vice-president: John F. Bovard, University of Oregon.

Secretary: Ellis Leroy Michael, Scripps Institute for Research.

Treasurer: L. L. Burlingame, Stanford University.

Executive Committee: Trevor Kincaid, University of Washington; Harry Beal Torrey, Reed College; Frank M. McFarland, Stanford University.

The society will take the place of the local biological societies of the Pacific Coast.

The Biological Society of the Pacific met at the Hotel Sutter, San Francisco, on August 4, for its annual meeting. The ad-

dress of the evening was given by Dr. Harry Beal Torrey, of Reed College, on "Research and the Elementary Student of Science." At this meeting the Biological Society voted to drop its organization in favor of the newly organized Pacific Coast Branch of the American Society of Naturalists.

THE forty-third annual meeting of the American Public Health Association, the fifteenth annual conference of the Sanitary Officers of the State of New York, and the annual meeting of the New York State Sanitary Officers' Association, will be held in Rochester, N. Y., September 6 to 10.

BEFORE the American Public Health Association on Tuesday evening, September 7, the presidential address will be delivered by Professor William T. Sedgwick, of the Massachusetts Institute of Technology, his subject being "Achievements and Failures in Public Health Work." Other speakers at the meetings are Dr. Hermann M. Biggs, New York state commissioner of health; Dr. W. C. Gorgas, surgeon-general United States Army, Washington, D. C., and the Hon. William C. Redfield, secretary of commerce.

DR. ALBERT EULENBERG, the distinguished neurologist of the University of Berlin, has celebrated his seventy-fifth birthday.

DR. VON STRÜMPELL, professor of medicine at Leipzig, has been elected rector for the ensuing year.

SIR A. SELBY-BIGGE, permanent secretary of the British board of education, has been appointed special secretary to the committee of the privy council for the organization and development of scientific and industrial research in Great Britain.

THE gold medal of the Company of Dyers, London, has been awarded to Professor A. G. Green, University of Leeds, and to Mr. W. Johnson, a research student of the University of Leeds, for research work in connection with the art of dyeing.

THE trustees of the American Medicine Gold Medal award have selected Surgeon-General Rupert Blue, of the Public Health Service, as the American physician who has done most for humanity in the domain of medicine during 1914, and the medal has been awarded to him for his work in national health and sanitation.

THE governor of Indiana has appointed a commission to investigate the causes and prevention of mental deficiency in the state. The medical members of the commission are Drs. George F. Edenharter, superintendent of the Central Indiana State Hospital, Indianapolis; Samuel E. Smith, superintendent of the Eastern Indiana State Hospital, Richmond; Charles P. Emerson, dean of the Indiana University School of Medicine, Indianapolis; Walter C. Van Nuys, superintendent of the Indiana Village for Epileptics, Newcastle; and Dr. George S. Bliss, superintendent of the State School for Feeble-minded Youths, Fort Wayne.

THE British secretary of state for the colonies has appointed a committee, presided over by Mr. A. D. Steel Maitland, parliamentary under-secretary of state for the colonies, to consider and report upon the present condition and the prospects of the West African trade in palm kernels and other edible and oil-producing nuts and seeds and to make recommendations for the promotion, in the United Kingdom, of the industries dependent on them. Mr. J. E. W. Flood, of the colonial office, is secretary of the committee.

DR. J. A. UDDEN, geologist of the bureau of economic geology in the University of Texas, has been appointed acting director of the bureau, the former director, Dr. Wm. B. Phillips, having resigned to become president of the Colorado School of Mines.

SIR AUREL STEIN, who has been making explorations in Central Asia, has arrived safely as Kashgar.

MR. CHARLES P. LOUNSBURY, chief of the department of entomology of the South African Union, expected to arrive in San Francisco about September 1. He has been spending some time in Australia and other points en route in furthering the interests of his department. He expects to be in America for several months.

The Reverend Alphone Schwitalia, S.J., professor of biology at St. Louis University, and two other members of the party, have returned from a medical inspection trip to British Honduras. Dr. Edward Nelson Tobey, assistant city bacteriologist and a lecturer at the university, also was a member of the expedition, but it is feared he perished with the steamer *Marowijne,* which has not been heard from since the West Indian hurricane swept through the Yucatan channel on August 13.

A memorial to Johann C. Reil, the anatomist, has been erected in Halle. It stands in front of the university clinic, the seat of his labors until called to Berlin in 1810. He died in 1813, aged fifty-five years.

The death is announced of Dr. B. Fisher, professor of hygiene and bacteriology in the University of Kiel.

The Paris Academy of Medicine has received a legacy from Dr. M. Sigaut of 8,000 francs to be awarded for a research on cancer of the digestive tract.

The exhibit arranged by the New York State Museum for the department of mines and metallurgy at the Panama-Pacific International Exposition was awarded a grand prize, besides one medal of honor, five gold medals, fifteen silver medals and nine bronze medals.

The Coast and Geodetic Survey informs the American Geographical Society of some recent significant soundings by the steamer *Pathfinder* in the southwest part of the Philippines area. The Cagayanes, Cavilli and Arena Islands, Tubbataha and Maeander Reefs, in the Sulu Sea, are apparently coral capped summits of a submerged mountain range extending for 200 miles southwesterly from the southwest part of Panay Island. They rise from depths of 6,000 to 12,000 feet with a stupendous submarine slope. The soundings indicate that this range divides the Sulu Sea into two deep basins by joining the shelf or plateau extending northwest of Borneo and east of Balabac Strait. Bancoran Island and Moyune Reef are elevations at the south end of the northwest basin. The Tubbataha Keys and Maeander Reef are the only elevations without vegetation. They are steep faced, similar in structure and consist of an accumulation of dead corals, coral rock and coral sand cemented into a greater or less degree of compactness. The pounding of the sea has accumulated the coral sand in the center to an elevation of five or six feet.

The Field Museum of Natural History has recently acquired a large collection of vertebrate fossils from the asphaltum beds of southern California. This collection consists of more than two thousand specimens varying from skeletons to single bones. Among them are mounted and mountable skeletons of the saber-tooth tiger (*Smilodon*) and the large wolf, *Canis dirus,* together with numerous series of skulls and skeletal parts of these animals. There are also skulls of *Megalonyx, Bison, Teratornis, Gymnogyps* and *Cathartes.* Other genera represented are *Felis, Camelops, Mastodon, Equus, Cervus* and *Antelocapra.* Most, if not all, of these specimens are of Pleistocene age. For this valuable collection the museum is indebted to the generosity of Messrs. E. E. Ayer, M. A. Ryerson, W. R. Linn and E. B. Butler, members of its board of trustees.

There has just been issued by the Bureau of Standards a paper describing briefly the methods of calibrating and using bomb calorimeters, such as are used in determining the amount of heat available from a given weight of coal or coke or other combustible. The amount of heat which can be obtained depends largely upon the kind and quality of fuel. When purchased in large quantities, therefore, a fuel is commonly tested to determine the amount of heat available per pound, and the price paid depends upon the results of these tests. The instrument used for such tests is called the bomb calorimeter and consists essentially of a steel shell or "bomb" in which a small weighed sample of the fuel can be burned in pure oxygen gas. The bomb is immersed in a known amount of water before the sample is ignited, the heat produced warms the water, and by suitable measurements of the change of temperature the amount of heat can be calculated. Provision is made

by the Bureau of Standards for standardizing bomb calorimeters by means of standard samples of certain pure materials, viz., sugar, napththalene and benzoic acid. By burning known amounts of these substances in the bomb the observer determines the amount of heat required to raise the temperature of the bomb together with the proper amount of water one degree. This being determined the amount of heat furnished by a given sample of coal burned in the same bomb with the same amount of water can be found. Thus these standard samples, which are sent all over the United States, serve as standards of heat and make it possible to get the same results from tests made anywhere in the country, much as the use of the standards of length and of mass makes a yard or a pound the same in all parts of the country. Copies of this paper known as Circular No. 11, "Standardization of Bomb Calorimeters," may be obtained without charge upon application to the Bureau of Standards, Washington, D. C.

The *Journal* of the American Medical Association reports that Mr. James Berry, who is at the head of a British hospital mission at Vrnjachka Banya, has collected from official sources figures which show that ninety-three Serbian physicians have died out of a total of 387 alive at the beginning of the war. Of these, no fewer than eighty-two succumbed to typhus fever, and only one was killed in battle. These figures contrast remarkably with those of the recent Turkish war in which Serbia lost only two physicians. Of the foreign physicians who have come to her aid in this war, thirty-five have died from typhus or typhoid fever. They include three British, four American, two Belgian, several Greeks, and six others.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. John Lee Coulter has been appointed dean of the College of Agriculture and director of the Experiment Station of the West Virginia University. He goes from the George Peabody College, and will take the place of E. D. Sanderson, who resigned about a year ago.

At the Johns Hopkins University, the degree of bachelor of science in education has been established in connection with the college courses for teachers and the summer courses. The degree will be open to men and women. The regulations concerning the work for the new degree will be determined by an advisory committee of the faculty. The title of director of the college course for teachers and of the summer courses has been assigned to Professor Edward F. Buchner.

Dr. Orin Tugman, of the staff of the research laboratory of the Eastman Kodak Company, has been elected associate professor of physics at the University of Utah.

Dr. L. Chas. Raiford, of the department of chemistry of the University of Chicago, has been elected professor of chemistry in the Oklahoma Agricultural and Mechanical College.

Dr. J. A. Menzies has been appointed professor of physiology in the University of Durham College of Medicine, Newcastle-upon-Tyne.

DISCUSSION AND CORRESPONDENCE

ANOTHER REASON FOR SAVING THE GENUS

I am writing to second Dr. F. B. Sumner's plea for the saving of the genus.[1] I am sure he has the sympathy of the great mass of workers in non-taxonomic biology. Leaving aside the question of expressing relationship in the generic name which Sumner has so well stated, there is another point that he has not sufficiently emphasized. It is by the genera that animals and plants are catalogued. In the *Nautilus*, Vol. 28, February, 1915, the writer made this plea. I illustrated it by the form on which I had been working for the past eight years, the genus *Lymnæa*. I quote the following passage from that paper:

> The most recent classification of this group is that of F. C. Baker in his admirable "Lymnæidæ of North and Middle America" (Chicago Academy of Sciences Pub. No. 3, 1911), p. 120. Whereas the older classifications considered shell characters alone, this author "proposed to classify the

[1] "Some Reasons for Saving the Genus," Science, Vol. XLI., No. 1068, p. 899.

Lymnæids by the characters of the shell, genitalia (shape of prostate, relative size and form of the penis and penis-sac) and radula."

On a basis of these criteria he has split the genus *Lymnæa,* as defined by Haldeman, 1840, Gould, Binney, 1868; Dall, 1871; Tryon, 1872 and 1884, and more recently by Dall in 1905, into six genera: *Lymnæa, Pseudosuccinea, Radix, Bulimnæa, Acella* and *Galba.* He has done this mainly by raising a number of subgenera and sections of former authors to generic rank. I wish to ask this question: Is this at the present time justifiable? (1) Baker lists 103 species and varieties of the old *Lymnæa* in this work. Of but 33 have anything of the anatomy, radula and genital organs been studied. Therefore the shell characteristics are the important ones after all. (2) All these new genera are based largely on quantitative characters. The only qualitative character mentioned is the radula and this is given quite a subordinate place in the classification. (3) In his diagnosis of the genus *Galba* in his key he states that the "Penis" (epiphallus) is shorter than the "penis-sac" (penis). However, for two of the species of this genus the epiphallus is longer than the penis. (See Baker, pp. 263 and 277.)

In the mind of the writer our present knowledge will not allow us to make a comprehensive classification of the Lymnæids based on the anatomy of the snail. We know too few species well. On the other hand, the shell characters alone in a mollusk with such a generalized form of shell as have the Lymnæids are not characters on which one can base much reliance. On account of these reasons the writer would make the recommendation that the old genus *Lymnæa* should be retained in the sense that it has been used for the past seventy years.

In the *Nautilus* for June, 1915, Mr. F. C. Baker answered the writer in an article entitled "On the Classification of Lymnæids." I think this may be taken as the typical attitude of a taxonomist. He said:

> The writer can by no means agree with the statement made twice in this paper (*loc. cit.*) that generic names should not be added unless based on undebatable grounds, because of the inconvenience of the cataloguer. If this criticism should be recognized we should revert to the use of many of the older names in the Pulmonata as well as in the Naides.
>
> It is recognized, of course, that generic subdivisions can be overdone, but in the advancement of science the convenience of the cataloguer or teacher is not considered.
>
> We welcome all additions to knowledge and we know full well that the work of yesterday is rendered obsolete by the work of to-morrow, but the writer can not see how the reduction to subgenera and sections of the names used as genera and subgenera in the monograph in question advances our knowledge of the family any more than the raising of a number of subgenera and sections to generic rank, as Colton believes the writer to have done in his monograph. This rather resembles a game of see-saw.

This whole discussion hangs on the question, is it necessary to change generic names to advance our knowledge? The writer believes that to change generic names without an overwhelming amount of evidence in favor of the change is hindering instead of advancing science. Species and minor groups, on the other hand, can not be too much subdivided. It is an advance to describe every variation that can be distinguished. Of this work Bateson[2] says:

> They will serve science best by giving names freely and by describing everything to which their successors may possibly want to refer, and generally by subdividing their material into as many species as they can induce any responsible society or journal to publish.

In conclusion, generic names are those by which animals are catalogued, therefore should not be changed without overwhelming evidence in favor of the change. This value of the generic name has not been sufficiently emphasized.

Harold S. Colton
Zoological Laboratory,
University of Pennsylvania

THE END OF CORY'S SHEARWATER

Cory's shearwater (*Puffinus borealis*) does not exist. It seems a pity to abolish so time-honored and respected a species; but the truth is that it already stands abolished, and nothing is required but the awakening of us American bird-men to the fact. It is indeed a token of provincialism on our parts that this remarkable error should have gone for thirty-four

[2] "Problems of Genetics," p. 249.

years uncorrected. For Cory's shearwater, described in 1881, was not a new bird, but an old bird with a new name. Its range is not unknown, and its nesting-habits and eggs have long been familiar to naturalists. As I have for some time suspected, as Howard Saunders stated positively away back in 1889, and as Godman in his "Monograph of the Petrels" (pp. 94–98, Part II., 1908) has established, *Puffinus borealis* is a synonym of *Puffinus kuhli*, the Mediterranean great shearwater, a common Old World bird which has been well known for generations.

My first intimation of this fact I found in Howard Saunders's "Manual of British Birds," wherein, on p. 716 (first edition), in treating of the great shearwater, he remarks:

> In the Azores, as well as on the islets near Madeira and the Canaries, the resident species is *P. kuhli* (identical with *P. borealis* of Cory), which visits the western coasts of France and the Peninsula, and is abundant throughout the Mediterranean; the latter species is of a much paler brown on the upper parts, and has a yellow-colored and deeper bill.

This was startling, since I knew that Saunders was not a man for unguarded statements; but at the same time it seemed incredible that an assertion of this kind in a standard bird-book should have remained unnoticed and uninvestigated by American bird-men for twenty years; and as Cory's shearwater still held its place in all our bird-books, I was puzzled. I recalled with intense regret the accidental loss of a specimen of *P. kuhli* which my father and I had once collected off Sardinia; and I set about trying to get together some skins of these big pale-billed shearwaters from both sides of the Atlantic, for comparison. Rosenberg, in London, wrote me that he had one skin only of *P. kuhli*. I meant to order this, and also to write to a bird-stuffer we knew in Cagliari, Sardinia; but other matters intervened, and I let the whole thing slip.

Then, hearing of Godman's "Monograph of the Petrels," I supposed it a matter of course that I should there find the question definitely settled. For some time I had no chance to see this work; and meanwhile I noticed that the latest-revised bird books in America were still hanging on to Cory's shearwater. Godman, then, had confirmed its standing as a distinct species? Apparently, this must be so. Yet the fact that in all these years a large shearwater breeding abundantly in the Azores had not been recorded even as a wanderer from our Atlantic coast seemed in itself an exceedingly suspicious circumstance. Strong-winged sea-rovers like these should find no barrier between the "Western Islands" and the New England fishing-banks.

My doubts continued until, in June of this current year, 1915, I was enabled through the kindness of the secretary of the Boston Society of Natural History to examine Godman's monograph. There I find the matter satisfactorily settled, in conformity with Saunders's statement and my own misgivings. Under the head of *Puffinus kuhli*, Godman (Part II., p. 96) says:

> Specimens from the eastern coast of North America have been described as *Puffinus borealis* by Mr. C. B. Cory, but I can not find any difference between individuals from the coast of Massachusetts and others from the Atlantic islands.

In his synonymy of *P. kuhli* he includes Cory's *P. borealis*.

It would seem unnecessary, not to say presumptuous, for us to question this determination, or wait to make further comparison of specimens before admitting that our "Cory's" shearwaters are simply Mediterreanean great shearwaters on their annual post-breeding-season pilgrimage to the fishing-grounds on the western side of the Atlantic. It must be noted, however, that the Azorean and Canary Islands birds have been found to be subspecifically distinct from those breeding in the Mediterranean, differing mainly in the smaller amount of white in the lining of the outer primaries. The Atlantic islands bird has been described by Hartert as *Puffinus kuhli flavirostris*,[1] and

[1] The name of *Puffinus flavirostris* was first used by Gould in 1834, for specimens of the Mediterranean (Azorean) shearwater from the Cape Seas. It appears that the species not infrequently wanders far southwards.

Godman states that the differences are inconstant, that a complete gradation evidently exists between the extreme types, and that the two forms can not be considered as more than subspecifically distinct. It is undoubtedly the Atlantic subspecies *flavirostris* which regularly visits our coasts. According to the American system, Number 88 of the A. O. U. Check-list, 3d edition, should evidently stand as *Puffinus kuhli flavirostris* Hartert, Yellow-billed or Azorean Shearwater.

GERALD H. THAYER

MONADNOCK, NEW HAMPSHIRE,
June 21, 1915

IRON BACTERIA

IT has been known for many years that some of the higher bacteria are concerned in the precipitation of ferric hydroxide from iron-bearing waters. Thus *Crenothrix polyspora,* which is often abundant in city water pipes where the water contains a small percentage of iron, is held to be responsible for the frequent turbidity of the water in such places, due to the separating out of ferric hydroxide, and also for the filling of pipes with ferric hydroxide which sometimes occurs. Certain other forms, like *Chlamydothrix ochracea, Spirophyllum ferrugineum* and *Gallionella ferruginea,* have been abundantly encountered in surface iron-bearing waters, where they form thick gelatinous deposits of yellowish-brown scum.

More recently certain lower bacteria have been described which show the same characteristics with regard to the precipitation of ferric hydroxide and which seem to be very abundant in surface waters.

Different investigators have attempted to explain this phenomenon in different ways. Some, notably Winogradsky and Lieske, believe that there is an oxidation from ferrous to ferric iron and that this furnishes the bacterial cell with energy. Lieske also claims that, as the iron is usually in solution as ferrous bicarbonate, the carbon dioxide set free by the oxidation is used by the cell for building up its tissues. Other investigators, like Molisch and Ellis, state that the precipitation of ferric hydroxide is a simple chemical phenomenon and is not connected with the life processes of the cell. They believe that the accumulations of ferric hydroxide upon these organisms or upon their remains is purely mechanical. At the same time they admit the association of iron bacteria with iron-bearing waters, and realize that ocherous scums in such waters consist largely of bacterial remains.

Most of the investigations on iron bacteria have been made in Europe and relatively few investigators have concerned themselves with the problem. At the present time the writer is engaged in a field and laboratory study of these organisms and it is hoped that this work may throw some further light on the peculiar phenomena connected with their activities.

During the field work it has been found that iron bacteria are present in almost all iron-bearing waters, surface as well as underground. *Crenothrix* and *Spirophyllum* have been found in city waters, *Spirophyllum* and *Gallionella* have been found in the underground workings of mines even to a depth of several hundred feet, while *Chlamydothrix* and *Spirophyllum* have been found in surface iron springs and bogs. It seems that the bacterial flora of different localities varies. In some localities iron-bearing waters have a mixed flora, while in other localities one finds almost pure cultures of one or another of the higher iron bacteria. Thus some iron springs contain big, fluffy masses of *Chlamydothrix,* while others contain a brownish-yellow deposit consisting almost entirely of *Spirophyllum.* Some mines contain in their underground workings only *Spirophyllum,* while others contain mixed cultures. The reason for this difference is not known, but it is possible that the character of the salts in solution influences the bacterial flora.

Lower bacteria, of the coccus or bacillus forms which precipitate ferric hydroxide, are more difficult to study than the higher iron bacteria, as they can be distinguished only by their physiological activities. In order to determine the general distributions of such organisms in nature various iron solutions were inoculated with different types of water and soil and it was found that ferric hydroxide was

precipitated from these solutions after an interval of time which varied with the different inoculations. These experiments show the almost universal presence of organisms capable of precipitating ferric hydroxide. In order to show definitely that organisms were responsible for this precipitation, sterilized duplicates of the different cultures were prepared and these did not show any precipitation.

It was found likewise that solutions of different iron salts are affected in a different manner during these inoculations. In some solutions no precipitate forms, perhaps because the salts used inhibit bacterial growth. In other solutions, notably solutions of inorganic salts, the precipitation of ferric hydroxide takes place almost immediately, due to oxidation by oxygen present in the solvent. Certain solutions were kept under anaerobic conditions by passing carbon dioxide through them and it was found that in some of them ferric hydroxide was precipitated while in others no precipitation took place. In general the experiments have shown that precipitation may take place from solutions of ferric, as well as ferrous salts.

Up to the present the writer's attempts to isolate the lower bacteria present in soil and water, which are responsible for the precipitation of ferric hydroxide, have been unsuccessful, but it is planned to prepare and to experiment with various kinds of media in order to bring about this result. Until this isolation has been accomplished it will not be possible to study their morphology.

The morphology of the higher iron bacteria, unlike that of the lower, can be studied very readily, as they can easily be distinguished from other types due to their characteristic form. While it is comparatively easy to cultivate such forms as *Crenothrix* and *Chlamydothrix* in the laboratory, it is extremely difficult to isolate them from other forms in order to study their physiological processes. This is because of the fact that numerous lower bacteria find lodgment on the threads of these higher types, and are continually transferred with them.

One of the principal points of interest in connection with these investigations has been to note the relation that the iron bacteria might have to the formation of iron ore deposits. It has been claimed that they play an important part in the formation of numerous small deposits of bog iron ore, and it seems possible that their activities may in part be responsible for extensive beds of sedimentary iron ore as well. Further, the fact of finding iron bacteria in underground mines opens the possibility that certain underground deposits of iron ore have been formed by them.

The writer hopes soon to publish a detailed report on the results of these various investigations.

E. C. HARDER

U. S. GEOLOGICAL SURVEY

A TYPICAL CASE

I HAVE read your correspondent's letter on "A Typical Case Exemplified" in the number of SCIENCE dated May 21, 1915, and I have been struck by certain parallels and differences in his case and my own case. I feel that perhaps my case is worthy of citation.

I, too, completed my work for the doctorate in one of the oldest and largest of eastern institutions and, after having spent a year as instructor there, came to the northwest at the invitation of the president of the institution and the head of my department with the promise that I should have a *fair* opportunity for original investigation. During my sojourn of five years here, I have encountered no such conditions as cited by your correspondent and know of no such conditions in any western institution with which I am familiar. Before completing my work for the doctorate, I spent my time in three western institutions as student and instructor. In all of them, I found the research spirit freely encouraged. In my experience I have never been told that research was personal and that I must bear the expense and take time for it from my recreation and sleep. As a rule, the man imbued with the research spirit is not likely to allow such obstacles to stand in his way without surmounting them and is likely

to suffer from a want of recreation and lack of sleep.

The problem before the western institution is quite different from that which confronts the older eastern institutions. The western institutions are in a state of flux and developing with the country. They are dependent upon the legislatures for part of their income. The legislatures are, as a rule, generous, but frequently the funds available for appropriation are not sufficient to meet all demands and some one must suffer. The difficulty of finance is one not characteristic of western institutions but nation wide. It thus happens that funds for investigation requiring elaborate apparatus and equipment are not always available. Such conditions can not be laid at the door of the administration which, as a rule, does the very best it can under given conditions.

Considerable space was devoted to the prominence of extension work and the popular place it occupies in the institutions' activity. It is true that extension work occupies an important position, but in no sense does it overshadow the research worker. The two go rather hand in hand. The extension lecturer should be a man possessing the research spirit if his extension work is to be of any educational value. Extension work is a legitimate function of a university in that it extends the truth, for no amount of exploration for truth is worth the effort it costs but extension be the ultimate end.

Undoubtedly your correspondent's case is a bona fide one, but to assert that such conditions which he cites are characteristic of our western institutions is fallacious. There are unquestionably institutions of the character he describes but they are not localized in any particular section of the country. No man need affiliate himself with such an institution, for the report of the Federal Educational Commission and other literature should give some evidence in one way or another of such a condition.

Our western institutions can not entirely disregard the research spirit, for they are looking towards a wider recognition in the educational world; and such recognition can come only from the attainments of the individuals composing the teaching staff. To suppress the spirit of original investigation is to cast them into utter oblivion in the field of higher education.

The thing with which I particularly wish to take issue in your correspondent's letter is the statement that research is impossible in the western university. The thing which I wish to emphasize is that no such condition is characteristic of the western institution, that sporadic cases do exist I do not deny, but such cases are not confined to the west but are scattered nation wide.

B. J. SPENCE

UNIVERSITY OF NORTH DAKOTA,
GRAND FORKS, N. DAK.

SCIENTIFIC BOOKS

The Determination of Sex. By L. DONCASTER, Cambridge University Press, 1914. New York, G. P. Putnam's Sons.

Professor Doncaster's book gives a popular account of recent work on sex determination, avoiding as far as possible technicalities which might embarrass the untrained reader. The author has succeeded in his difficult task of presenting a considerable body of matter, much of it controversial, to a general audience. He points out that determination of sex means not the control of sex (*i. e.*, the production of sex at will) but the study of the causes that lead to the appearance of males and females. "We may discover the causes of storms or earthquakes, and when our knowledge of them is sufficiently advanced we may be able to predict them as successfully as astronomers predict eclipses, but there is little hope that we shall ever be able to control them."

Doncaster is not a little concerned that the use of the word cause in connection with sex determination be clearly understood. A factor *A* may be invariably followed by a condition *E*, but between the two there may be a chain of events *B, C, D*. Should *B* or *C* or *D* be produced in some other way this would also lead to *E*. Similarly for sex, a female results when certain conditions are realized in the egg, a male when other conditions prevail. This general philosophical point of view will,

of course, be readily conceded as an article of broadmindedness; meanwhile we must wait for a specific case where it can be shown that males and females may be turned out in these different ways. For, while no one doubts that such things as blue flowers, let us say, may be due to different pigments that go back in origin to different factors, yet so far as known to the reviewer there is no case in the whole Mendelian literature where it has been *proved* that the same (not merely similar) product is the result of different factors.

A somewhat similar question comes up in connection with certain attempts that have been made to account for departures in the sex ratio on the basis that the sex factor has become "weakened." The result would lead to complete mix-up of the chromosome relations and would lead to chaos in subsequent generations if the same kind of "weakness" kept up. In contrast to such speculations the relative constancy of the chromosome number must appear an impressive fact. Doncaster himself, while lending a sympathetic ear to those who find difficulties in applying the chromosome interpretation to sex determination, takes in general the stand with which most of us will heartily agree, namely, to hold fast to what has been most clearly demonstrated and not let the fact that there are still unsolved problems confuse the issue. Progress in the difficult field of biological research seems to start from those points where the situation is clear. The ever-present attempts of the obscurantist to befog the issue by over emphasizing what is not understood is a procedure too familiar to call for more than passing comment. Doncaster's book will therefore serve to give balance to the situation that is "developing normally."

There are few minor points in the book that call for comment. The author has, on the whole, most judiciously assigned special discoveries to their authors without overburdening the text with names. The omission of Stevens's name on page 63 in connection with the discovery of the XY chromosomes in relation to sex determination is an oversight, but some fuller mention might have been expected in connection with the history of these chromosomes when much less important matters receive their historical setting.

T. H. MORGAN

COLUMBIA UNIVERSITY

The Butterfly Guide: a Pocket Manual for the Ready Identification of the Commoner Species found in the United States and Canada. By W. J. HOLLAND, LL.D. $3\frac{1}{2} \times 5\frac{3}{4}$ inches; pp. 237; 295 figures in color. Doubleday, Page & Co. Cloth. $1.

Any guide book to the identification of 255 species of butterflies, that contains 295 finely colored figures, that costs only a dollar and actually does go into a vest pocket, may truthfully be called a great little book. This, in a few words, is a fair description of Dr. W. J. Holland's "Butterfly Guide." Apparently it is the first of its kind, and also the last word (and picture) in butterfly books for availability in the field and home.

The thirty-thousand-copy success of Dr. Holland's original "Butterfly Book" may justly be regarded as the inspiration for the present elegant booklet; and the author's point is well taken. This manual is built on the same general lines as Chester A. Reed's Pocket Bird Guide Series, and the "Birds of New Jersey." True enough, these volumes are none of them "reading books," and in the business of furnishing means to ends in identifying species they stick closely to their trails.

The purpose of this almost bewildering array of colored butterfly pictures is to promote identification of strange species, literally in a moment; and right well do they serve their purpose. Remembering as we do the breezy and rare freshness of the author's literary style, the only regret about this volume is that it does not and can not furnish room for unlimited Hollandesque gossip and disquisition on the more interesting species.

W. T. H.

SPECIAL ARTICLES

A NEW DISEASE OF GERMINATING WHEAT

WHILE examining some wheat fields on April 16 of this year it was noted that there was a

considerable unevenness of the stand, there being quite a proportion of very weak plants. It was known during the season of 1914 that these fields were infested by the wheat straw worm, *Isosoma grande* Riley, and it was thought that the weakened plants were due to infestations of this insect. Careful examination, however, did not reveal the presence of larvæ in the unthrifty plants. While making observations two weeks previous to this time it was noted that the emerged females of the wheat straw worm, *Isosoma grande*, were ovipositing in the wheat plants, and it was naturally our first thought, on examining the fields the second time, that the weakening of the plants was due to the attack of the larvæ. It may be said in passing that the wheat plants were largely volunteer, although some additional seed had been sown in the field.

A number of these plants were carefully examined in the laboratory and it was found that the attached wheat kernels were infected with a fungus which had apparently destroyed their contents at or near the time of germination. Pure cultures of the organism were made and it was found that the fruiting was typical in every respect excepting on nutrient agar cultures, or cultures which tended to become dry too readily.

A search of the literature indicates, in so far as I have been able to determine, that this disease has not been heretofore noted and that the organism has not been previously described. The fungus clearly belongs to the genus *Podosporiella*. We find only one other species under this genus, namely, *Podosporiella humilis* Ell. & Ev. The fungus is not truly parasitic, but seems to attack the wheat kernel about the time of germination, completely destroying the contents in very much the same way that the kernel is destroyed by smut. The result is that the wheat seedling, not getting the proper food supply in the early stages of growth, is permanently dwarfed and produces few stools. The crop yield is much reduced.

An extended description of the fungus and the characteristics of the disease will be given in the near future, at which time the fungus will be named as a new species of *Podosporiella*.

P. J. O'Gara

OCCURRENCE OF THIELAVIA BASICOLA AS A ROOT PARASITE OF WATERMELONS IN THE SALT LAKE VALLEY, UTAH

During the current season my attention was called to a serious trouble of watermelons, *Citrullus vulgaris* Schrad., in which all the plants in an entire field had been lost and even a second planting had largely died. Many of the plants came above the ground in an apparently healthy condition, but soon wilted or "damped off." Some that did not wilt had a chlorotic appearance and upon carefully removing them from the soil it was found that the lower part of the root system had been destroyed. These plants had developed many lateral roots above the point of injury. Examination showed that the roots were badly infected with the fungus *Thielavia basicola* (B. & Br.) Zoph. In going over the literature I find that Gilbert[1] gives a considerable list of hosts and the distribution of the fungus. This list does not include the watermelon and it is therefore apparent that the watermelon is a heretofore unreported host for this fungus. So far as the writer has been able to determine, *Thielavia basicola* has not been found in any part of the United States west of the Mississippi River; at least, it has not been found as an active parasite.

The fungus has been isolated in pure culture and has fruited characteristically, agreeing perfectly with the descriptions as given in the literature.

P. J. O'Gara

OCCURRENCE OF THE BACTERIAL DISEASE OF SUDAN GRASS IN THE SALT LAKE VALLEY, UTAH

Only very recently has Sudan grass, *Andropogon sorghum*, been introduced into Utah, and with it apparently has been introduced the bacterial disease. Very recently some specimens were brought to the laboratory for examination, where it was found that they were badly diseased. The elongated, red-brown blotches were extremely numerous and had caused the death of many of the leaves.

1 Bulletin 158, Bureau of Plant Industry, U. S. Department of Agriculture, October 7, 1909.

Most of the lower leaves were entirely dead. On the under surface of the spots there was apparent the characteristic red crust or scabs. This crust consisted of dry bacterial ooze which had come from the interior of the blade. When sections of the younger spots were put in a droplet of water and placed under the microscope the bacteria could be seen oozing from the infected portions in enormous numbers. Pure cultures were readily obtained; some of the plates contained practically no other organism but the causative agent. Colonies on nutrient neutral agar formed rather slowly, being circular, white or pearly-white in appearance. On putting a platinum needle into a colony and lifting it, it was noted that the organisms adhered in such a way as to be stringy or sticky and could be drawn out to considerable length.

It was at first thought that the organism might be one previously described by Smith[1] as *Bacterium andropogoni*, but there seems to be little doubt that the disease is due to the broom-corn bacterial organism first studied by Dr. Burrill, namely, *Bacillus sorghi* Bur. This disease is one of the chief drawbacks to the culture of Sudan grass on the Gulf Coast, but whether it will be serious or not in the Salt Lake Valley remains to be seen. During the present season the month of May was very rainy and humid and this probably accounts for the rather serious infection of the plants. Under normal weather conditions it is quite possible that the disease will not prove a serious drawback to growing Sudan grass as a forage crop.

P. J. O'Gara

Salt Lake City, Utah,
June 28, 1915

The Pendulum Key and its Use for Recording the Beats of a Metronome

The pendulum key is a short lever, pivoted at one end, and held vertically. It is so arranged that a slight lateral displacement of its lower end causes it to make an electrical contact. A platinum pin in this part of the lever strikes against a platinum plate fastened to the insulated piece from which the lever is suspended. This simple apparatus is an excellent arrangement for recording the beats of a pendulum or a metronome. The writer has found it easy to construct such an instrument by making a few additions to a key with a platinum contact made by the Harvard Apparatus Company, and used in physiological laboratories to make and break a current by hand. The sketch shows the key with the additions to hold it in a vertical position. The

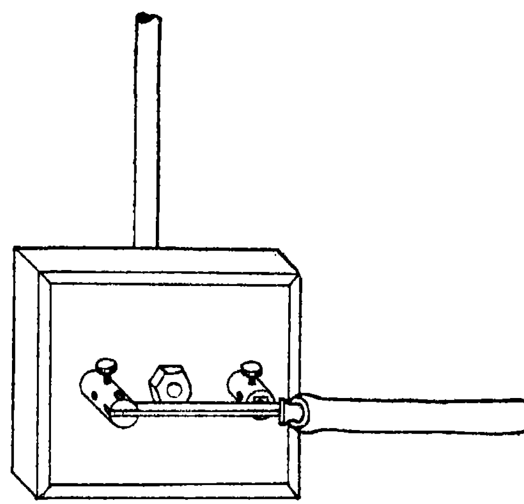


Fig. 1.

end of a short stud passes through a hole drilled in the middle of the slate base, and is held by a nut. A steel rod is screwed into the other end of the stud with its axis parallel to the plane of the base, and at right angles to the axis of the stud. The rod is held horizontally by a clamp fixed to the vertical rod of a tripod stand. By slightly rotating the key around the horizontal rod as an axis, the distance separating the platinum point from the plate against which it strikes can be varied to any desired extent. The lever can be lengthened by slipping one end of a short piece of rubber tubing over the handle, as is indicated in the figure. The tubing acts as a spring in breaking the shock of the impulse of the vibrating rod. The apparatus is placed in such a position that it receives a slight tap at the end

1 "Bacteria in Relation to Plant Diseases," Vol. 2, 1911, Erwin F. Smith.

of the swing of the pendulum; the pin is brought in contact with the plate, closing an electric circuit, which actuates a time-marker writing upon the recording surface. As the lever rebounds, and does not make contact again until it has received another impulse, the electric closure is almost instantaneous.

The great advantage of this simple arrangement is that it does not involve any alteration in the apparatus with which it is used. A cork disc or ball slipped upon the end of the vibrating rod is the only addition to the metronome that is required. The disadvantages of a mercurial contact are avoided, which is always desirable, unless special reasons require it.

The apparatus has been tested with a recording tuning fork and it has been found to give satisfactory results with the metronome, which, of course, should only be used in experiments of moderate accuracy. The key is probably much more reliable than the metronome with which it is used. Comparative tests of the key and the well-known tambour device for recording the beats of a metronome were also made, and the key was found much more convenient and accurate.

I have ventured to describe this inexpensive piece of apparatus, as its simplicity and efficiency would seem to commend it to all those who employ the metronome in recording time.

FREDERICK W. ELLIS
MONSON, MASS.

SOCIETY OF AMERICAN BACTERIOLOGISTS

V

Industrial Bacteriology

Under the supervision of R. E. Buchanan

Problems in Soil Bacteriology: JACOB G. LIPMAN.

The student of soil bacteria, and of other soil microorganisms, is often struck by the fact that there is, apparently, localization of one or another of the species in certain spots. To what extent is this localization characteristic of fields, small areas in any one field, or soil particles of different mineralogical or other origin? We know, of course, that the water films surrounding the individual soil particles represent solutions of varying composition and concentration. But we have no knowledge, except of an indirect character, as to the very interesting differences which must exist as to the numbers and kinds of bacteria in the water film surrounding individual particles.

From other fields of bacteriology, we know that there may be associative action, and likewise antagonism, among species of soil bacteria. But we know practically nothing of these relations in the soil, nor how these relations may be modified by soil treatment or by climatic conditions.

It has always been my belief that the beneficial results ascribed to applications of commercial fertilizers or of other materials may be due as much to the action of such materials on soil microorganisms as to the action on the crops themselves. There is need now for the study of soil bacteriological problems from this point of view.

Another problem which is widely recognized of importance to soil fertility is the formation of so-called humus in the soil. Admitting that humus is the result of biological activities, it is for us to discover how the composition of the resulting product is affected, not only by vegetable and animal substances from which it is derived, but by the type of microorganisms concerned in its formation.

To the problems already mentioned, I might add the systematic study of temperature, moisture, aeration and pressure as factors in influencing bacteriological activities in the soil. It is possible also, that so-called stimulants, like manganese, copper, zinc, etc., may react on the activities of soil microorganisms. These problems should receive the attention of, preferably, a large number of workers. It may be added that these and other problems studied systematically will help to throw light on the production and modification of plant food in the soil and on the great industry of crop production.

The Solution Versus the Soil Method for the Bacteriological Examination of Soils: P. E. BROWN.

From a careful study of the methods which have been employed for the bacteriological examination of soils, it is concluded that the "fresh soil" method is the most rational which has yet been devised. A recently proposed modification of the solution method, while eliminating some of the objections to the old method, is considered to possess many objectionable features, so many as to be of very questionable value for the interpreting of results from the fertility standpoint. It is urged that careful comparative tests be carried out, in order to settle definitely the question of which is the "best" method for the bacteriological examination of soils.

Relation of Lime to Production of Nitrates and Mineral Nitrogen: F. M. SCALES.

The lime requirement of an acid soil was determined by adding varying quantities of calcium carbonate to weighed portions of the soil, moistening and, after an hour, testing with litmus paper until a quantity was found that gave a neutral reaction. The lime requirement by the Veitch method was the same as the above. Fractions and multiples of this requirement were added to 100 gm. portions of soil which received in addition for one duplicate set ammonium sulphate and for another duplicate set alfalfa powder. They were moistened with 18 per cent. of distilled water and incubated for three weeks at 28° to 30° C. Determinations of nitrate and mineral nitrogen present in the samples showed that the nitrifying bacteria were most active in the presence of 50 per cent. of the calcium carbonate requirement and the ammonifying and nitrifying groups combined in the presence of 75 per cent. of the amount required according to the chemical determinations. In this particular soil an excess of calcium carbonate was markedly toxic for the nitrifying organisms and not stimulating for the ammonifiers. Some common crop plants are to be grown on this and other soils containing varying quantities of lime to determine what relation exists between the lime requirement for optimum nitrification and for ammonification and nitrification combined and that for the best growth of the plants.

A Soil Sampler for Soil Bacteriologists: H. A. NOYES.

The object of this sampler is to furnish a piece of apparatus which will sample the soil under one system of cultivation as well as under another. It also becomes the container for the soil after the sample is taken.

The sampler is a brass tube 11 inches long, with one end made into a cutting edge. This cutting edge is so made that the soil is not appreciably compacted when the sample is taken. The end having the cutting edge is furnished with a tight-fitting brass cap two inches in height. The open end, plugged with absorbent cotton, makes the sampler complete. The procedure in using this apparatus follows: Plug and cap as many samplers as you wish to take samples of soil; sterilize them in the hot air sterilizer and take them to the field. Remove a cap from a sampler, insert the driving head above the cotton plug and drive the sampler into the ground to the desired depth, pull it out, flame and return the cap and the sample is ready to take to the laboratory.

The sampler has the following properties which are important in bacteriological work: Easily sterilized; easily kept clean; easily manipulated; durable.

The Effect of Phosphates and Sulphates on Soil Bacteria: E. B. FRED.

The influence of inorganic fertilizers on the bacterial processes of the soil has not received much attention. For this reason a study of the effect of some of the pure salts of those elements which constitute an important part of commercial fertilizers was undertaken.

The aim was to determine, if possible, the influence of phosphates and sulphates upon the activities of soil bacteria and determine if the fertilizing effect of these substances could be explained in part by the promotion of bacterial action.

The following methods were employed:

Rate of ammonification in solution and in soil; this was conducted with pure and with mixed cultures of bacteria. Aside from this, determinations were made of the relation of the number of cells to the amount of nitrogen ammonified. To show this relation, plate counts were used. The nitrogen for ammonification was added to the solution in the form of peptone and to soil in the form of casein. The rate at which the nitrogen of these substances is converted into ammonia, was determined by distilling with magnesium oxide. The cultures were incubated at room temperature and at different intervals the amount of ammonia determined.

Monobasic potassium phosphate in peptone solution caused a great increase in the production of ammonia. This is noted with a pure-culture yellow ammonifier and with a suspension of soil bacteria. The gain was greatest at the end of the first two days.

Merck's precipitated calcium phosphate caused a slight increase in ammonification, but not nearly so large as the monobasic potassium phosphate.

Sulphates of calcium and potassium increased ammonification to a small extent.

The action of monobasic potassium phosphate was far greater than that of potassium sulphate. From this it seems that the potassium ion does not materially influence ammonification.

The results of plate counts show that monobasic potassium phosphate causes an enormous increase in multiplication of bacteria. This is followed by a rise in ammonia. The ammonia production, however, is not in proportion to the number of bac-

teria. This seems rather to be a result of increase in the number of cells than increase in individual cell activity.

All of the phosphates gave a large increase in the number of soil bacteria. There was only a slight increase from the sulphates.

The same relative effect of phosphates and sulphates was noted in the case of carbon-dioxide evolution.

From the results of this work, as a whole, the following conclusion may be drawn:

That possibly the increased crop production which results from the application of soluble phosphates is due in part to the promotion of bacterial activity.

The details will appear in a future publication.

The Effect of Green Manures on the Germination of Various Seed: E. B. Fred.

When green manures are turned under and the soil planted immediately, a decrease in germination may result.[6]

This problem was considered of sufficient importance to warrant a series of field and laboratory experiments in an endeavor to find some explanation for this phenomenon. The causes that might be offered to account for the harmful influence of green manures on seed germination are:

First, that the green manure not only causes a marked increase in number of bacteria, but also a change in the flora.

Second, that the great increase in number of bacteria results in a possible accumulation of some substance or substances, toxic to germination.

Third, that the rapid multiplication of microorganisms greatly increases their metabolism.

In order to gain some idea of the practical importance of this problem, a series of field tests was conducted. The results of this work show that when green clover or oat tissue is turned under and the land planted immediately, there is a distinct decrease in the rate of germination with cotton, soy bean and hemp seed. The cereals, corn and oats fail to show any injury from green manures. After twenty-five days the injurious factor seems to have disappeared entirely.

Under greenhouse conditions it has been found that small amounts—0.25 per cent.—of green manures are injurious to the germination of cotton seed. Larger amounts are more effective.

The addition of calcium carbonate to the green manure fails to prevent the injurious action.

The degree of retardation seems to vary somewhat with the soil type; in heavy soils green manures have their most marked effect; furthermore an increase in moisture causes a decrease in rate of germination.

When peptone and casein are added in the same nitrogen ratio as the green manure, no decrease in germination is noted. Soluble carbohydrates in amounts of 1 to 2 per cent. retarded the rate of germination, but did not cause the seed to decay as in the case of green manures.

Determinations of carbon dioxide and ammonia in green manure soils were made. Periodic analyses failed to show the presence of these in quantities great enough to account for the injury to seed germination.

A more complete report of this work will appear in bulletin form.

Standard Methods of Bacteriological Analysis of Milk: H. W. Conn.

Professor Conn gave an account of an extended series of cooperative experiments in four laboratories in New York upon the reliability of the bacteriological examination of milk, and as a result of the facts that were brought out by the cooperative tests, reported that the Committee on Standard Methods of the American Public Health Association had made the following changes in methods of milk analysis.

First, that beef extract (Liebig) be substituted for beef infusion in the making of agar media.

Second, that 1.2 per cent. dry agar or 1.5 per cent. ordinary moist agar be the amount used in standard medium.

Third, the acidity of standard medium shall be 1 per cent.

Fourth, all plates shall be incubated at 37½ degrees for 48 hours before counting.

Fifth, plates shall be counted with a magnifying power of 3½ diameters.

The Alkali-forming Bacteria Found in Milk: S. Henry Ayers and Philip Rupp.

The alkali-forming bacteria may be broadly defined as those which produce an alkaline reaction in milk within 7 days, due to the oxidation of salts of organic acids, which results in the formation of alkali carbonates. No visible sign of peptonization is produced.

Probably all the alkali-forming bacteria produce ammonia upon long inoculation, but the preliminary alkaline reaction is due to the production of alkali carbonates and not to ammonia. The presence of alkali carbonates in milk can be determined by the addition of casein dissolved in sodium phosphate.

[6] Hoffman, Exp. Sta. Bull. 228, 1913, p. 26.

Alkali-forming bacteria are very common in milk, but would rarely be noticed on litmus-lactose agar plates. They can be found by inoculating into tubes of litmus milk and observing the reaction after 7 to 14 days' incubation at 30° C.

The alkali-forming bacteria can obtain their nitrogen from meat juices, peptone, casein, gelatin, and many can also, with few exceptions, use nitrogen from inorganic salts, such as sodium ammonium phosphate and probably all ammonium salts; also from sodium nitrate and nitrite.

The best source of carbon seems to be the salts of organic acids.

Since various cultures ferment salts of different organic acids, we hope to be able to classify this group of bacteria on these fermentations. In sugar broths only an alkaline reaction is produced and consequently the sugar fermentation is of no value as a means of classification.

We believe the fermentation of salts of organic acids will be of great value in the classification of bacteria, particularly soil bacteria, which do not ferment sugars when present in broth.

Decomposition of Casein in Presence of Salt by Butter Flora: Chas. W. Brown.

The casein in butter during storage is slowly broken down into amino-acids and ammonia. Nitrogen, as amino-acids and ammonia, in percentage of the total nitrogen in unsalted butter (average of tubs from three creameries) was found to be 5.71 per cent. at first and 7.59 per cent. after 240 days' storage at 21° F.; in salted butter from the same three churnings and stored in the same storage was found 5.71 per cent. at first and 8.19 per cent. after 240 days. And again, in salted butter made from pasteurized and from unpasteurized cream, the percentage (average of 20 tubs) increased from 6.24 to 6.86 per cent. for the pasteurized and from 7.68 per cent. to 8.25 per cent. for the unpasteurized during storage at 0° F. for 428 days.

Pure cultures of twelve different bacteria isolated from storage butter when introduced separately into flasks of sterile separated milk and also into other flasks of the same milk to which was added 5 per cent. sterile salt and incubated at 20° C., caused a decomposition of the casein during 1, 3 and 7 days as follows: The nitrogen (per cent. of total milk) found as caseoses and caseones (average for 12 different bacteria) was 0.031 per cent., 0.037 per cent. and 0.054 per cent. in plain milk; and 0.030 per cent., 0.034 per cent. and 0.042 per cent. in milk with 5 per cent. salt; the nitrogen found as amino-acids and ammonia was 0.031 per cent., 0.042 per cent. and 0.076 per cent. for plain milk and 0.028 per cent., 0.035 per cent. and 0.041 per cent. for salted milk.

While the activities of butter flora in the decomposition of casein milk with or without salt can not be considered to parallel their action in butter, yet can we not assume safely that at least part of the casein decomposition in butter is due to the butter flora?

The Presence of Streptococci in the Milk of Normal Animals: J. M. Sherman and E. G. Hastings.

In many public-health laboratories the routine examination of milk includes tests for streptococci. The supposed relation between udder streptococci and septic sore throat in man is the reason for making such examinations.

The examination of the milk from 88 individual animals in four herds demonstrated the presence of streptococci in 38.6 per cent. of the samples of milk. The animals were all free from udder trouble. The examination of the product of twelve herds demonstrated the presence of streptococci in the milk of ten of the twelve examined. In all of the above cases 1/100 c.c. of milk was used.

It would seem that the milk of healthy animals frequently contains streptococci at the time it is drawn from the udder, and that before much emphasis can be placed on the detection of these organisms in milk, methods by which harmful types can be differentiated from the harmless ones must be devised.

The milk of most of the herds examined was used chiefly for the feeding of children. No known cases of trouble have resulted.

The Refrigeration of a City's Milk Supply: Carleton Bates.

This paper sets forth the plan of a milk campaign as conducted by the Bureau of Chemistry, U. S. Department of Agriculture. It further sets forth the results of the bacteriological examinations of a city's supply, the causes of the high bacteriological counts obtained, and means employed for remedying the causes.

The chief cause of the high bacteriological counts was due to non-refrigeration of milk in transit, the average temperature of the milk upon receipt in the city being about 65° F. This milk was en route from six to twelve hours.

After refrigeration had been provided by the railroads the milk, at the present time, is being received in the city at about 48° F.

Slimy and Ropy Milk: R. E. BUCHANAN AND B. W. HAMMER.

A study of slimy and ropy milk sent for examination to the Dairy Bacteriological Laboratories of Iowa State College has shown the following:

1. Cultures of organisms secured from slimy starters, apparently typical *Streptococcus lacticus* forms, sometimes showed marked capacity to produce ropiness when inoculated into sterile milk.

2. Associative action of organisms in some cases is responsible for ropiness.

3. *Bacterium* (*lactis*) *viscosum* is one common cause of slimy milk.

4. Certain peptonizing bacteria, as *Bact. peptogenes* produce a very slimy residuum after digestion of the casein.

5. *Bacterium bulgaricum* and certain related high acid organisms frequently produce marked viscosity in milk.

Sliminess in milk, therefore, is apparently due to different causes with different organisms.

Methods of control and prevention of slimy milk are discussed.

Descriptions of thirty-three species of bacteria that have been found associated with milk are given, and the literature reviewed.

Factors Influencing the Resistance of Lactic Acid Bacteria to Pasteurization: K. PEISER.

In milk and cream pasteurized at 63° C. (145° F.) for twenty minutes in a "Perfection" Pasteurizer (200 gal. capacity) were found a number of strains of the *Bact. lactis acidi* type whose thermal death-point in broth is below the pasteurization temperature.

The thermal death-point of a number of these strains was determined in bouillon (10° acid to phenolphtalein) and in boiled whole milk, separated milk and milk serum, with the result that the average thermal death-point is in whole milk 5° C., in separated milk 2.5° C., and in whey 0.5° C., higher than in bouillon. These results indicate that the protection given to the suspended lactic bacteria by the casein and coagulated albumen of separated milk raised their thermal death-point 2.5° C. and that the protein and fat of whole milk raises their thermal death-point 5° C. In this we see a reason why some bacteria whose thermal death-point is low are found in pasteurized milk.

Bacteria in Preserved Eggs: MAUD MASON OBST.

Commercial and strictly fresh June eggs packed in solutions of 1: 5, 1: 10, 1: 15, 1: 20 parts commercial waterglass, and in saturated lime solutions were stored in laboratory, barn, cellar and at 34° F. Thermograph records were kept. Bacteriological and chemical examinations were made, also cooking experiments and parcel-post shipments.

Temperature of 80° F. in laboratory permitted rapid multiplication of bacteria in eggs.

Barn temperature varied from 10° F. to 87° F. Eggs froze in solutions, later some thawed without breaking and at end of experiment showed no effects attributable to freezing. Bacterial content was uniform and fairly low. Bacterial increase in commercial eggs in 1: 10 waterglass was rapid, especially in albumen, during first two months of storage.

Eggs stored in cellar held a uniformly low bacterial content throughout experiment.

At 34° F. eggs showed exceptionally low counts.

Waterglass solutions contained practically no bacteria per c.c. after five months of storage. Average bacterial content of eggs in nearly every lime solution increased more rapidly than in waterglass, necessitating the discard of certain lime solutions early in experiment.

Curves were plotted showing increase of average bacterial content in relation to length of storage. Bacterial content of albumen in most cases remained lower or equal to that of yolks for 150 or 250 days of storage, then the former increased markedly and generally far exceeded that of the yolk.

From good eggs were isolated: *M. aurantiacus*, *B. prodigiosus*, *B. subtilis*, *B. pyocyaneus*, *B. fluorescens liquefaciens*, *B. termo*, *B. zopfi*. One decomposed egg contained *B. proteus* in large numbers.

Some Methods and Appliances Used in the Elementary Courses in Bacteriology: W. H. WRIGHT AND E. G. HASTINGS.

A description of the laboratory equipment used with large classes.

The Effect of Certain Organic Soil Constituents on the Fixation of Nitrogen by Azotobacter: BRUCE WILLIAMS.

This paper reports a study on the effect of various organic compounds on the growth of Azotobacter. The compounds used were those likely to be constituents of the soil.

One liter Erlenmeyer flasks, to which were added 15 grams of pure sea sand, previously washed and burned, afforded an excellent surface upon which *Azotobacter* developed. To each of these flasks was added 100 c.c. of Ashby's media.

The flasks were sterilized under 15 pounds of steam pressure for 15 minutes. After this sterilization, the compounds were introduced into the flasks in desired concentrations and all flasks received equal inoculation of pure cultures of *Azotobacter* previously grown on Ashby's agar and suspended in sterile water. Two flasks were set up for each compound in every concentration and two control flasks receiving only inoculation were used to test the fixation power of the culture used. All flasks were incubated for 21 days, at the end of which time nitrogen determinations of the content of each flask were made by the Kjeldahl method.

In studying compounds which contain nitrogen four flasks instead of two were set up with each compound, two of the flasks receiving inoculation with *Azotobacter* and the remaining two used as controls for the nitrogen content of the compound—these latter flasks were kept in the incubator room during the period of incubation.

The concentrations employed were on the basis of p.p. Mil. or 0.025, 0.05, 0.1 and 0.2 gram per liter.

The results of the study indicate that fixation of nitrogen by *Azotobacter* is only slightly influenced by most of the compounds investigated.

Hydroquinone and salicylic aldehyde revealed the most toxic properties of any compounds studied.

Esculin, quinic acid and borneol afforded marked stimulation to the growth of the organism.

The effects of the compounds on *Azotobacter* are not, as a rule, in accord with what has been reported of their action on the higher plants. In concentrations which are fatal to certain higher plants, many of the compounds only slightly depressed fixation.

Such compounds as nicotine, picoline, guanidine and skatol exhibited toxic properties commensurate to those usually ascribed to these substances. Caffeine appeared to stimulate the growth of the organism.

Many of the nitrogenous compounds used which have been reported as beneficial to higher plants exercised a marked depression on fixation. It appears that the simpler compounds were more pronounced in this respect than were the more complex ones. It is suggested that this condition is not one of toxicity, but that the nitrogen of the compounds was utilized by *Azotobacter* in preference to that of the atmosphere. Urea, glycocoll, formamide and allantoin were especially active in depressing fixation.

Relation of Numbers of Streptococcus lacticus to Amount of Acid Formed in Milk and Cream: P. G. HEINEMANN.

Erlenmeyer flasks were filled with 250 c.c. each of milk and cream. Three flasks of each series were sterilized and then inoculated with a culture of *Str. lacticus* in litmus milk. Three flasks of raw milk and cream were also inoculated. Three flasks of each were left to sour spontaneously. The flasks were incubated at three different temperatures, 37°, 20° and 7°. Plates were prepared from the original milk or cream and the number of bacteria counted. The acidity was determined by titration with one twentieth normal sodium hydrate phenolphthalein as indicator. Every day for ten days the milk was titrated and counts made by plating. The determinations were made with the cream for eight days.

The following facts were observed:

1. The amount of acid formed during the souring process of milk or cream is not solely dependent upon the number of bacteria present of the *Str. lacticus* group. Temperature and the presence of other bacteria may influence the result.

2. In raw milk or cream or in raw milk or cream inoculated with cultures of *Str. lacticus* the number of bacteria increases to a given point and then decreases. The higher the temperature up to 37° C. the earlier is the maximum number reached.

3. Coagulation of milk or cream is not dependent solely upon a certain amount of acid or a certain number of bacteria.

4. After the decline in numbers the amount of acid continues to increase, probably due to enzyme action.

5. At 37° extraordinarily large amounts of acid may be formed, due probably to the presence of members of the group of lacto-bacilli.

The Variability of Two Strains of Streptococcus Lacticus: P. G. HEINEMANN.

The present investigation was conducted to determine the possibility of varying the fermentative power of *Str. lacticus* by animal passage. Two strains were isolated and inoculated into rabbits and guinea-pigs. The amount of acid produced by the original culture was determined by titration after three days' incubation at 37° C. After each passage the recovered organism was again inoculated into the solutions of test substances and the acid determined again. The amount of available free oxygen was regulated by filling nessler tubes with definite amounts of the

test solutions. The test substances used were dextrose, lactose, saccharose, raffinose, inulin, salicin and mannit.

The main conclusions reached by the work are:

1. The power to hemolyze human and goat's blood may be acquired to some extent by animal passage.

2. Animal passage develops and increases virulence of *Str. lacticus*.

3. Virulence develops more rapidly in rabbits than in guinea-pigs.

4. By animal passage the amount of acid produced in the original strain decreases progressively and fermentation of some of the substances is inhibited.

5. Raffinose and inulin, which were not fermented by the original strains, were fermented to a limited degree after animal passage.

6. Presence of free oxygen seems to favor the production of acid. Under anaerobic conditions less acid was produced than with free access of oxygen. Under anaerobic conditions fewer substances were fermented than under aerobic conditions.

Bacterial Infection of Fresh Eggs: Dorothy W. Caldwell.

This paper presented the results of a bacteriological study of fresh eggs carried on at the Agricultural Experiment Station of the Rhode Island State College. The results are, briefly, as follows:

1. Of 2,510 fresh eggs from 65 hens, examined by the indirect method, 8.8 per cent. showed infection in the yolk.

2. None of 111 whites examined showed infection, while the yolks of the same eggs gave a percentage of infection (4.5) less than the average for the series (8.8).

3. The percentages of infection obtained for individual hens per year varied between 2.8 and 15.0, the average being 8.0 per cent. per year. No hen laid sterile eggs during a whole year.

4. No correlation was observed between the percentage of infection for any individual and the degree of fecundity of that individual.

5. Approximately the same amount of infection was found among fertile eggs (6.9 per cent. infected out of 422 eggs examined) as among infertile (8.9 per cent. infected out of 315 eggs).

6. The infection of eggs in the degree made apparent by the present studies seemed to have no unfavorable effect upon their hatchability.

7. Practically no difference between the percentages of infection of eggs from pullets and from hens in their second laying year was found.

8. No definite seasonal variation was observed in the bacterial content of the eggs examined.

9. No definite conclusions can be drawn from these studies regarding the influence of temperature upon the detection of infection in fresh eggs.

10. From fifty-seven infected eggs out of 737 examined in one of the series, 37 bacterial types were isolated, among which were seven cocci, eleven motile rods, eighteen non-motile rods and one spirillum.

11. Control plates exposed under the hood in which the examinations were made yielded a variety of organisms, largely chromogens. This series, as a whole, did not resemble the series of egg organisms.

Regarding the source of infection, this study indicated that the penetration of the shell after the egg had been laid, or infections during the passage of the egg through the cloaca, or during fertilization or while the albumen or the shell were being deposited, are, to say the least, uncommon. It seems more likely that infection of fresh eggs is largely due to occasional chance infections with harmless organisms taking place within the ovary of the fowl.

A New Microscopic Test for Pasteurized Milk: W. D. Frost.

This test differs from a similar one described in 1911 by Frost and Ravenel, in the method of applying the stain, the nature of the stain and the principle involved. A few cubic centimeters of milk have mixed with them one fifth as much of a saturated aqueous solution of methylene blue. This colored milk is allowed to stand about 30 minutes; it is then centrifuged and the sediment spread on a glass slide. When dry it is ready for examination.

In raw milk the microscopic field is stained a uniform blue in which appear clear areas which are either fat globules or leucocytes. The polymorphonuclear cells are irregular in outline, about 12 mikrons in diameter and unstained or only slightly tinged. The sediment from milk heated to 60° C. or above presents a very different picture. The polymorphonuclear leucocytes are rounded up and shrunken so that they are only about 8 mikrons in diameter and the nuclei are deeply stained.

The method requires little more time than it does to make a fat determination and is apparently as simple and accurate as the laboratory diagnosis of diphtheria or rabies.

A. Parker Hitchens,
Secretary

SCIENCE

FRIDAY, SEPTEMBER 10, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

CONSERVATION AND THE VETERINARIAN[1]

As civilization advances and freer commerce develops with other nations, new conditions arise. New dangers menace our plant as well as our animal food supply. As farmers must now contend with the San José scale and other insect pests which formerly caused no concern but now threaten his fruit and other crops, so must the veterinarian realize that new dangers in the form of foreign diseases as rinderpest, foot and mouth disease, trypanosomes and possibly others may at any time invade our territory. Aside from the possibility of the danger of this foreign invasion, the diseases already established here in the form of glanders, anthrax, tuberculosis, abortion and sterility are sufficient cause for the most serious apprehension. The condition may soon arrive, if it has not already arrived, when, in certain sections, it will be difficult to maintain the normal size of the herds, letting alone the question of surplus stock for the market, because of the ravages of bovine diseases. If there is or should be difficulty in maintaining the size of the herds as they now are, the problem of rearing surplus animals is indeed a serious one.

The old order changeth. The day when the only desirable practise was in the city, and this was concerned principally with the horse, has gone by. While the automobile has undoubtedly affected city practise, it is no more likely to supplant the horse

[1] A portion of the president's address presented at the twenty-sixth annual meeting of the New York State Veterinary Medical Society, Ithaca, N. Y., August 3, 1915.

than did the trolley cars and bicycles. Aside from his use as a beast of burden, the horse will still be indispensable in safeguarding human lives by the production of serums and antitoxins. Within our own generation there was a time when the price of farm products sank almost to the vanishing point. In some of the northwestern states, it was reported, horses could not be given away and many were turned loose upon the plains and mountain-sides to gain what sustenance they could. This was not far from the period when the automobile first began to attract notice, and although the automobiles have shown a phenomenal increase in number, the census returns show, also, a marked increase in the number of horses and a still greater increase in their value. The demand for horses from this country in connection with the European war will serve to stimulate their production, and for a period after the war we may expect a further demand in order to restock the countries that are now being devastated. With his master the horse has taken an important part in war and the conquest of nations. Like his master he is subject to death and fearful injury. It is therefore no more than an act of justice that in the present war an organization known as the blue cross has been effected for the purpose of aiding wounded horses. Above all is humaneness. This quality needs cultivation in time of peace as well as war and veterinarians will do well to consider it not only in their own practise, but by showing a sympathetic interest and activity in local humane societies.

While the civilized world has shuddered at the horrors of the trenches of the European warfare, there has been a tragedy of the trenches in our own country which, although not seriously involving human life, has nevertheless caused great hardship and paralyzed agricultural pursuits in certain localities.

The lives of thousands of our domesticated animals have been sacrificed, threatening more or less seriously our food and milk supply. This foreign invasion of an insidious infectious disease has necessitated the expenditure of a vast amount of money and has invoked the highest skill and strategy of the veterinary profession to exterminate an enemy so fatal to our resources.

Although the trenches have been filled and the green sod of the pasture marks the lasting resting-place of the many victims of the foot and mouth disease, there remains an aftermath of bitterness on the part of many stockmen and others who have suffered loss from the ravages of the disease and the restrictions imposed by the quarantine. This bitterness has been directed largely toward the Bureau of Animal Industry, because of delay in diagnosis and quarantine restrictions. The sentiment of hostility has been crystallized in a resolution adopted by the National Society of Record Associations representing thirty-four pure-bred-stock breeder's associations with a combined membership of 110,000 breeders of pure-bred live stock in the United States.

This resolution puts the association "on record as favoring and strenuously urging that the live-stock interests . . . be represented in an official capacity in the United States Department of Agriculture by an assistant Secretary of Agriculture who shall be a practical stockman, and not a scientist by profession, such officer to be the ranking officer in immediate charge of the live-stock interests and sanitary regulations administered by the Bureau of Animal Industry."

A second resolution "urges the adoption of state and national legislation providing

for just compensation at market value for all stock, pedigreed or otherwise, destroyed by state or nation, in the work of extirpating animal diseases; such compensation to be fixed by two appraisers, one appointed by the sanitary authorities and the other by the owner of the stock, etc."

The bitterness has apparently been intensified by the appraisals of the agents of the bureau, unsatisfactory to the owners of pure-bred and high-grade live stock. There are apparently two questions involved: one is the delay in diagnosis and quarantine, the other is the matter of the appraisal of prize cattle. Thus far only one side of the question has been heard and it would seem fitting that judgment of the bureau should be suspended until the report of the committee of investigation is available. Whatever the blame for the outbreak, there can be no serious criticism of the efforts of the veterinarians to eradicate it. All that was humanly possible was done to check its progress after the disease was determined, and it is only fair to render credit for what has been accomplished. We do not believe the veterinarians should be deposed as administrators of sanitary affairs. We do not believe a stockman, "not a scientist," no matter how high his business qualifications, could have rendered more efficient service in cleaning up the outbreak than have the veterinarians.

Sanitary administration is one thing; appraisal is another. Appraising does not come in the veterinary curriculum. We believe the two should not be confused. The second resolution of the National Records Association is an admission that the remedy for this cause of bitterness is legislation by the states and nation and in this remedy the stockman may expect the hearty cooperation of the veterinarian. It is gratifying at this time to say that New York state is the first to enact legislation of this character. Because appraisals are not satisfactory is no reason why veterinarians should be displaced in the administration of sanitary affairs. The remedy is in legislation.

Lamentable as this experience with foot and mouth disease has been, it points the way clearly, among other things, to the fact that a technical veterinary education should be built upon something more than a grammar-school foundation. Something more than the general education of a child of thirteen or fourteen years should form the basis of a preparation for technical studies which are to fit him to stand as a bulwark of protection between insidious diseases, on the one hand, and the health of millions of dollars' worth of live stock, on the other.

Some years ago a former Secretary of Agriculture, with the idea of improving the service of the United States Veterinary Inspectors, through a committee of veterinarians, formulated certain changes in the curricula of the veterinary schools. The recommendations of the committee were converted into regulations by the Secretary of Agriculture and the United States Civil Service Commission. Although it was stated that there was no desire to control the schools, but merely to make known the requirements of the government for graduates who planned to enter the service of the Bureau of Animal Industry as veterinary inspectors, the effect was much the same as control, as apparently none of the intitutions were desirous of being omitted from the list of eligible schools as published by the department. We have always felt that the secretary erred in regarding the curriculum as more important than the man.

To improve conditions it would seem logical that the effort should begin at the foundation and that it should be unneces-

sary for outbreaks of animal diseases involving millions of dollars of property to force home to us the fundamental knowledge that it is the quality of the man that counts.

One basic step toward the prevention of a repetition of serious outbreaks in the future is the requirement of at least a high-school rather than a grammar-school foundation for a proper veterinary education. The National Society of Record Associations, representing 110,000 breeders of pure-bred live stock, and the Secretary of Agriculture may do well to consider seriously an agitation for and an insistence upon a better fundamental education for those who are to enter veterinary work. The veterinary can not take its place with other learned professions until it conforms to the same standard of requirements. The fault has been with the system. The weak link in the educational chain has been the low entrance requirements. With this link strengthened, with a strong foundation upon which to build the veterinary curriculum, there is hope for the future.

A further safeguard against outbreaks of infectious diseases is the establishment of a system of district veterinarians on a plan similar to that in use in some foreign countries. If county agents are of benefit in the progress of agriculture, if the twenty health supervisors of the state are of service in the physical uplift of the population by preventing and restricting human diseases, then it is equally important in the conservation of our resources that there should be district veterinarians. The duty of a district veterinarian should be to keep a close supervision over all transactions involving the possible introduction and spread of infectious diseases of animals as well as other matters pertaining to them. He should also have supervision over a state meat inspection service. Bovine tuberculosis alone, the control of which is estimated to cost the state about $3,000,000 annually, would warrant the services of a skilled veterinarian in each district. Such an arrangement is not an experiment; its efficiency has already been demonstrated in other countries.

As pointed out by Dr. Moore,[2] the wide distribution of foot and mouth disease has illustrated in a striking manner the necessity of having a competent veterinarian in each district to guard against such infections. Had there been *a competent district veterinarian* in the county where foot and mouth disease first appeared last August, it is highly probable that its spread would have been checked before its virus had been so widely disseminated. If by this extra precautionary measure one per cent. of the loss from such diseases could be prevented, the amount it would save the state would many times overpay the expense of such service. A bill embodying the features just enumerated was before the legislature at its last session, but, unfortunately, failed to become a law.

In no other profession, perhaps, are there as many temptations in the way of commercialism as in the veterinary profession. The desire to win and retain the good will of certain clients, who may themselves be dishonest and are willing to pay for dishonest tests and falsified records, may serve as a pitfall for a weak veterinarian. Opportunities are not wanting in the case of glandered horses, tubercular cattle, certified milk and other instances for veterinarians intentionally or through carelessness, indifference or criminal negligence to inflict great damage upon the public and bring their own profession into disrepute. Human life may pay the toll of this negligence. Falsified records and incompetent tests may brand the person making them as

[2] *Cornell Veterinarian*, April, 1915.

an unconscious murderer of little children. Greater criminality than this can no man possess: that he jeopardize the lives of his kind for the sake of money. In no profession is there greater need for self-control and the exercise of the strictest honesty and personal integrity.

The conservation of our domesticated animals and their products is of the highest importance to the welfare of our nation. The following figures are taken from the census of 1910. They are the latest *official* figures available, although probably inaccurate at the present time. During the last five years there has probably been an increase in the number of veterinarians. In this period, also, there has probably been a decrease in the number of some of the domesticated animals because of the ravages of foot and mouth disease and established diseases as well as a decline, more or less fluctuating, in production.

The figures show that in 1910 there were in this country on farms and not on farms 206,646,069 domesticated animals, including cattle, horses, mules, asses, burros, swine, sheep, and goats, with a valuation of $5,296,421,619. With 11,652 veterinarians in this country, we have a ratio of one veterinarian to 17,734 animals, or in financial terms one veterinarian to $454,550 of animal valuation. While this average is higher in some parts and much less in others, it serves to emphasize the fact that a great responsibility rests upon the veterinarian if he is to assist, not merely in the conservation of much valuable animal stock already in existence, but in promoting a still greater production. The necessity for this is obvious in the case of the animals used for food. The census returns show a decrease of 8.7 per cent. in the number of cattle on farms with an increase of 1.6 per cent. in their valuation; a decrease of 7.4 per cent. in swine with an increase of 72.1 per cent. in their valuation, and a decrease of 14.7 per cent. in sheep with an increase of 36.8 per cent. in their valuation. Horses, mules, asses and burros have increased in number during this period and their valuation shows a much higher percentage of increase than in the case of the food animals.

It has been figured that our average disease loss of live stock in the United States is $150,000,000 and our exposure loss $44,000,000, a total of nearly $200,000,000 annually. It is evident that few industries could endure such proportionate losses and survive. The largest toll has been taken from the food-producing animals. We may assume that practically all losses from exposure are preventable and that this item will diminish as the open-range boundaries contract and better provision is made for the winter sustenance of stock.

The checking of the disease loss is a slower and more serious matter and it is here that the services of the veterinarian are necessary. To meet this obligation he must be something more than an uneducated, practical horse doctor more or less successful in the treatment of spavins, ringbones, colics and other routine cases of practise. He must be able to see beyond the educational horizon which treats only of routine practise and, with a proper blending of scientific and practical training, show an appreciation not only of personal but community interest in the animal resources of our country.

PIERRE A. FISH
ITHACA, N. Y.

QUANTITY AND QUALITY

PROFESSOR ÉMIL BOREL, who visited America in 1912 as one of the inaugural lecturers at the opening of the Rice Institute of Houston, Texas, recently embodied some of his impressions about America in an article under the

above title, published in the April, 1915, number of the *Revue du Mois*. As this article was written by a Frenchman after the beginning of the great European War, it has naturally been very much influenced by feelings aroused by events connected with this war.

The central thought of the article is that there is a great tendency to lay too much stress on quantity and too little on quality in speaking about scientific achievements. It is perhaps natural, under the conditions existing while the article was written, that the author concluded that the Germans had done most during the last forty years to acclimatize in Europe the conception which makes quantity the sole criterion for the social, intellectual and moral values of the people. Many American readers may however regret to find that this conception is said to be of American origin, even if this statement is modified by the fact that the most cultured Americans are striving to habituate their countrymen to judgments based on quality.

Among the illustrations given by Professor Borel in support of his contention that the Germans have in recent years unduly emphasized quantity is the following small table, which aims to give the approximate number of letters in an average volume of certain important mathematical periodicals:

Mathematische Annalen ..	1,680,000
American Journal	1,014,000
Journal de Mathématiques..	1,012,000
Acta Mathematica	980,000
Journal für Mathematik ...	875,000
Annali di Matematica	825,000

This table was first published at the end of the "Generalregister" to the first fifty volumes of the *Mathematische Annalen*. About two years after its publication the *Transactions of the American Mathematical Society* began to appear in volumes involving a much larger number of letters than the *American Journal*, which occupies the second place in the given list. While it may be questioned whether it is desirable to direct special attention to the mere size of the volumes of a periodical the given table has at least an indirect value, since it furnishes an interesting concrete illustration of the meaning of a million.

As questions relating to quantity are much more easily treated by statistical methods than those relating to quality, the growing popularity of statistical methods, even in educational matters, seems to be a sign that we are at present placing too much emphasis on quantity at the expense of quality. Mental inertness naturally leads to considerations of quantity rather than of quality. It is much easier to enumerate the books and articles written by a certain man than to exhibit the value and influence of these publications. It is easier to estimate a man's wealth in dollars than to determine the merits of his intellectual contributions or his moral influence on his fellows. It is easier to give the number of students at a university and the size of the budget than to estimate the value of the work done at the institution.

In view of the fact that questions of quantity are usually much easier than those relating to quality, it is perhaps the more surprising to find that Professor Borel attributes to America the origin of the conception which makes quantity the unique criterion for social, intellectual and moral values of the people. If this criticism is not deserved it should certainly not pass unanswered, for the implications which it involves are fundamental and far-reaching. The fact that the criticism was made by a man of very high scientific standing, who recently spent some time in our midst and in company with some of our leading men, makes it all the more noteworthy.

It is perhaps especially interesting that the tendency to make quantity the sole criterion for *intellectual* values should be regarded as being of American origin. Intellectual leadership even along somewhat baneful lines implies vigorous intellectual life, and it is of some interest to find that we are credited with such life by a competent observer. As Professor Borel is a mathematician it would appear probable that his conclusions in regard to the intellectual activities of a people would be largely influenced by their mathematical productiveness. It can, however, not be said

that the quantity of mathematical output on the part of the Americans is, or has ever been, such as to justify the statement that the conception of making quantity the sole criterion in regard to mathematical activity originated with us. As regards quantity we never had any mathematical writer who could be compared with Euler, Cauchy, or Cayley.

It is true that in recent years the quantity of American mathematical literature has increased rapidly, but the same is true in regard to this literature in several other countries. As evidence of the fact that the United States is not inclined even at the present time, to go to excess in regard to the quantity of its mathematical literature we refer to the recent publications under the general direction of the International Commission on the Teaching of Mathematics. At the Paris Conference held in April, 1914, the extent of these publications reported by various countries was as follows:

Country	No. of Pages
Germany	3,822
Austria	690
Belgium	348
Denmark	107
Spain	165
United States	670
France	674
Holland	151
Hungary	130
British Isles	853
Italy	253
Japan	788
Roumania	16
Russia	254
Sweden	229
Switzerland	812

As questions relating to teaching offer unusual opportunities for extensive publications the above table is very instructive as regards tendencies towards quantity along mathematical lines. It seems therefore unlikely that Professor Borel had mathematics in mind when he referred to our undue emphasis on quantity. It is much more likely that he was impressed by the fact that our conversation and our newspapers are so largely confined to questions of quantity. In a comparatively new country the changes as regard quantity are so rapid as to attract wide attention, and these changes furnish the easiest topics of conversation. Changes as regards quality may be no less rapid but they furnish less harmless subjects of conversation in view of inherent difficulties and room for differences of opinion.

It is perhaps unfortunate that our conversation even in regard to intellectual matters is so commonly directed by a desire to offend no one instead of by a desire to call attention to what is very important. The thoughtful foreigner who comes into our midst is thus naturally impressed by the fact that we so commonly speak of harmless quantity instead of the more important quality. Some years ago while talking with a great French mathematician I was much impressed by the fact that, in speaking about two of his eminent colleagues, he was very free in saying which of the two he regarded as the more eminent. I felt then that in America I would probably not have found such voluntary reference to such a delicate matter.

The seriousness of this question becomes apparent if it is observed that the tendency to refrain from referring to quality in a public way is reflected to some extent in the life of the people. If in a university community, for instance, it is regarded as undesirable to refer to the quality of the work of the various members of the faculty, and if the quantity of salary is the sole index of relative standing, there is apt to be little effort on the part of the younger men to attain to a greater degree of efficiency. Many questions of quality appear shocking only in view of their newness. After they have passed into the stream of allowable conversation topics they are not likely to offend anyone and they often serve a useful purpose. In fact, the inefficiency of a university professor often becomes a perfectly harmless topic. The danger lies in the early stages towards such publicity as regards the true conditions, and it is here where there is usually the greatest field of usefulness.

The greatness of a nation in the intellectual and moral life is largely influenced by its emphasis on quality. Professor Borel urges that

it is the duty of France to restore the preëminence of quality and he points out that the way towards this end is easy. In fact his suggestions are "to give to quality opportunity to manifest itself, do not hide it under a bushel, for men never refuse to recognize the intellectual or moral superiority which is pointed out to them; their natural sentiments of equality and justice, far from being shocked by this, are exalted thereby. The young people, in particular, regard themselves united with the comrade whom they have learnt to appreciate; far from being jealous of his success, they are happy with him."

These suggestions should be equally useful among us where the need of reform is even more evident than in France. Our great western state universities are doubtless especially in danger of being overwhelmed by judgments of quantity, in view of their very direct contact with the public. They present therefore unusually important centers for emphasis on quality, and for guarding against being absorbed in the work which admits of exhibition in attractive circulars presenting statistical data in regard to quantity. Public references to quality of work and to the deeper joys and compensations of intellectual life are especially needed in these institutions.

The very rapid growth of our educational institutions has naturally led to an abnormal interest in changes in quantity. It is so easy and harmless to speak of the increase in the material equipment. It is much more difficult and delicate to make clear that the intellectual advances made by the faculty have kept pace with these material advances, or that the moral and intellectual influences surrounding the students are better than they were in former years. These latter questions involve comparisons, and they frequently lead at first to differences of opinion. They are, however, the more important, and the foreign scholars who may be in our midst will judge us very largely by the way we deal with these questions of quality. It will be very unfortunate if we continue to impress these men as we seem to have impressed Professor Borel, especially since such impressions seem to represent only our superficial attitude, at least, as far as they relate to our intellectual and moral life.

G. A. Miller

University of Illinois

FREDERIC WARD PUTNAM

With Professor Putnam, who died on August 14, at the age of seventy-six years, the last of the three men has passed away who may well be called the founders of modern anthropology in America: Brinton, Powell and Putnam. Brinton in Philadelphia, with keen, analytic mind, full of imagination, with wide interests, opened up ever new fields and problems and stimulated through his personal influence the work of others and paved the way to the recognition of anthropology as a scientific study. Powell performed the great service of organizing the anthropological work of the government by founding the Bureau of Ethnology and providing in this manner the means for scientific research. With rare insight he selected an unusually gifted group of men around himself, and to their labors we owe the fundamental data on which modern American ethnology has been built up. Through the sheer force of his personality he impressed some of his fundamental philosophic views and some of his methods upon his collaborators not only in the Bureau of Ethnology, but in a much wider group of scientists that came under his influence, and gave in this manner to anthropological studies a definite direction that may still be recognized.

Professor Putnam's contributions were of another kind. Taught in the Agassiz school of independent search for facts, he took up anthropological studies with that enthusiastic worship of material data as the indispensable basis for inductive studies that has dominated his life and that, together with his skill as an organizer, have made him the most potent factor in the development of anthropological institutions all over the country. Owing to the trend of his mind, his interests centered in the objective, tangible sides of anthropology and, therefore, his chief contribution lies in the development of museum work. The search for well authenticated Indian material and his in-

terest in biological problems led him to lay particular stress upon archeological evidence, and in this field he did his most noteworthy work.

The Peabody Museum of American Archeology and Ethnology is, perhaps more than anything else, a monument of his life work, for in it are manifested the varied phases of his many-sided interest in the history of mankind, as exhibited by man's handiwork and by the remains of the races of man. The osteological department, surpassed only by the old collections of the Army Medical Museum in Washington, the materials relating to the study of the antiquity of man in America which he pursued with unconquerable tenacity, the collections from the mound and village sites of Ohio, the ample and valuable material from Mexico and Central America, the old New England collections, archeological as well as ethnological, not to mention others, indicate the lines of his own scientific activities.

In one respect he revolutionized American museum methods. While it has been customary to enlarge collections by purchase, he inaugurated scientific expeditions, the prime object of which was the discovery of scientific facts that were sustained by the evidences of collections. Journeys for the purpose of collecting had been made before his time, but he had the courage to emphasize that in museum expeditions, as in other scientific work, the method must be determined not by the number of specimens likely to be secured, but by the objects of the inquiry. To him the museum was the storehouse in which the materials accumulated by scientific research were cared for, digested and made accessible to the student. His constant insistance on this point of view gave to his museum work special value.

The development of the Peabody Museum and his wide acquaintance among American men of science and among those interested in the advancement of science, brought it about that his capacity as an organizer was sought in other centers in which there was a growing interest in archeology and anthropology. It was he who laid the foundation to the Field Museum of Natural History by organizing the Anthropological Department of the World's Columbian Exposition in Chicago. There he solved the difficult task of bringing together in a short time material illustrating prehistoric America as well as the primitive life of the historic American Indian. With this accumulation of material he combined scientific investigation that bore fruit in later times in the intensive work among Indian tribes carried on by a number of institutions. Some of the important archeological results of this period still await publication. Together with the treasures of the Peabody Museum and those of the Museums of Ohio they will elucidate a remarkable period in the history of early America, the thorough exploration of which was begun and carried along for years by Professor Putnam. Unfavorable conditions prevented the completion of this work that was always near to his heart. The opportunities offered by the World's Columbian Exposition enabled him also to advance the work of securing replicas of the monuments of Central America, a subject to which he devoted much of his time and energies.

At the close of the World's Fair he was called to New York to organize the anthropological work of the American Museum of Natural History, and here we find him introducing the same methods of development that had been so effective in building up the Peabody Museum as a center of scientific research. The field investigations of the New York Museum extended beyond the narrow limits of the North American continent and inaugurated a period of active scientific research.

His great success as an organizer brought it about that when the development of anthropological work, partly owing to his influence, was planned in the University of California, he was called upon to take a vigorous part in the formulation of plans for a museum and for the scientific work of the newly founded department of anthropology which followed much the same lines as those inaugurated by him in other institutions.

While these four large institutions had the benefit of the stimulus of his sustained per-

sonal efforts, many others were helped by his advice and assistance.

Professor Putnam's influence has been great in still other ways. He succeeded in having anthropology recognized by Harvard University as a regular subject of instruction, with the result that an ever-increasing number of students became interested in this subject. His influence as a lecturer was, however, not as great as that of his personal contact with students. Through his sympathy with the personal interests of younger men, through his eagerness to help them along on the arduous path of the young scientist, he associated with himself a large number of young anthropologists who were filled with that enthusiasm for the unbiased collection of data that characterized his own work. The precedent set by Harvard University, and at the same time by Clark University, and Professor Putnam's unceasing agitation have done much to introduce anthropology as a subject of study in our universities. Men who have grown up as his students are now found in many American and Canadian institutions.

Professor Putnam's activities were not by any means confined to the field of his own researches, but he took a lively interest in the advancement of scientific work in the whole country. This quality, his genius as an organizer, and his sympathetic nature brought him into prominence in the work of the American Association for the Advancement of Science, of which he was for many years permanent secretary and which he made a most efficient means of promoting and extending the influence of science. It is a well-marked period of scientific development that his incumbency of the secretaryship represents: the extensive and gradual deepening of scientific interest. It covers the period preparatory to the specialization of more modern times that makes the American Association more an administrative clearing house of special scientific bodies than an agency that promotes popular interest and that gives to the young scientist the opportunity to gain his first laurels.

For several years Professor Putnam had been ailing, but his robust nature withstood vigorously the attacks of an insidious disease. On the occasion of his seventieth birthday his many friends gave expression to their warm feelings towards him by the publication of an anniversary volume containing contributions from almost all American anthropologists. His influence, that of a sane and sober scientist who values facts higher than fancies will be lasting, and we honor and love one who has helped to lay the foundations on which we are permitted to build.

FRANZ BOAS

COLUMBIA UNIVERSITY

PAUL EHRLICH[1]

PAUL EHRLICH was a genius of the first order. While he was still a student of medicine, the problems presented by the affinity of lead for certain tissues attracted his attention. From speculating on the nature of this affinity, his interest grew to include protoplasmic affinities in general, and thus was determined the direction his genius should take.

Some of the notable results of his early investigations are discoveries in bacterial staining methods, which proved of great value to Koch and which, ever since, have been in daily use everywhere; the micro-chemical differentiation of leukocytes, on which rests the study of the blood for clinical purposes; the development of the methylene blue reaction of living tissues, and the formulation of that unique conception of protoplasmic structure and function on which he based the great side-chain theory which he advanced to explain the reactions in immunity and other phenomena.

What might be termed the second phase of Ehrlich's work concerned investigations in immunity under the guidance of the side-chain conception. No better illustration of the practical usefulness of the imagination in creating a successful working hypothesis can be given than the results achieved by Ehrlich in the field of immunity. Perhaps the usefulness is seen most clearly in the standardization of

[1] From the *Journal* of the American Medical Association.

diphtheria antitoxin, which was a direct outcome of experiments devised according to the side-chain idea. Ehrlich's method, to the exclusion of others, is used all over the world; but the influence of the work carried out to test the side-chain theory of Ehrlich and his pupils still dominates investigation in all branches of immunity and the practical use of the knowledge obtained therefrom.

The side-chain theory is so well known that it is not necessary to restate it except in the most succinct form. A toxin or other antigen is without action on the animal body unless bound by molecular chains in the cells—receptors. But when so bound, the antigen causes injury to the cell, and subsequent repair, in the course of which there is an overproduction of receptors, which, passing into the blood and lymph, constitute the antibody for the antigen in question, because the antigen is now bound and neutralized or destroyed before it can reach the cell. As expressed by Behring, antibodies are free cell receptors, and the elements which, when situated in the cells, are essential for the action of toxins, for instance, are also the means of healing when free in the blood. In accord with the principles of this theory, Ehrlich's vivid mind coined numerous new words, which proved helpful in the discussion of new facts and ideas, and which soon passed into current international usage.

Ehrlich's last work was the development of the experimental chemotherapy of syphilis and certain other spirochetal infections. To discuss this wonderful work fully in all its ramifications is not possible at this time. The scientific world has accepted "the development through a lengthy series of systematic biochemical experiments, based on original conceptions of the affinities of cellular constituents, of a successful chemotherapy of important human infections, by direct attack on the parasites by substances specially built up for that purpose and introduced from without," as the fitting culmination of the tireless activities of an altogether unique investigative spirit. As pointed out elsewhere, Ehrlich's results in experimental chemotherapy fully justify Huxley's prediction in 1881 that through discoveries in therapeutics it would become possible "to introduce into the economy a molecular mechanism which, like a cunningly contrived torpedo, shall find its way to some particular group of living elements and cause an explosion among them, leaving the rest untouched."

Paul Ehrlich will live in the history of civilization as one of the great investigators, genial, creative, fertile, excelling in "that boldness of the scientific use of the imagination which alone can extend beyond the obvious fact and reveal the unknown," one of the great benefactors of mankind.

THE NEW YORK BOTANICAL GARDEN

THE New York Botanical Garden at Bronx Park is celebrating this week the twenty-fifth anniversary of its foundation. The first session was opened at nine o'clock Monday morning, September 6, with registration of delegates in the library, followed by an inspection of museums, laboratories, library and herbaria, with special reference to the exhibition of painting of plant life by Mary E. Eaton in the herbarium, and the Charles Finney Cox collection of Darwiniana. After lunch in the Museum Building the delegates and guests were formally welcomed by W. Gilman Thompson, president of the board of managers; by Henry H. Rusby, chairman of the scientific directors, and by Thomas W. Whittle, commissioner of parks for the Bronx. Dr. N. L. Britton, director-in-chief, then read "A History of the New York Botanical Garden."

Tuesday, September 7, was set for the reading of papers. According to the program these included: "Mechanism and Conditions of Growth," by D. T. MacDougal; "Mosses from Florida," by Elizabeth G. Britton; "Directing Factors in the Teaching of Botany," by Arthur H. Chivers; "Flora of the Mammoth Cave, Kentucky," by R. Ellsworth Call; "Triassic Plants from Sonora, Mexico," by Edwin W. Humphreys, and "A White-Cedar Swamp on Long Island and Its Significance," by Norman Taylor; "On the Nature of Types," by

R. A. Harper, and "Present Status of the Problem of the Effect of Radium Rays on Plant Life," by C. Stuart Gager.

Wednesday, September 8, was to be given up to a study of the flora of sand dunes and salt marshes on Crooke's Point, S. I., the excursion being planned in cooperation with the Staten Island Association of Arts and Sciences. On Thursday the reading of papers was to be resumed, including Clifford H. Farr on "Cell-Division: Bipartition and Quadripartition in Pollen Mother-Cells," and "Ecology and the New Soil Fertility," by Charles B. Lipman; John K. Small on "Recent Explorations in Southern Florida"; H. Hus on "A New Interpretation of Fascination"; P. A. Rydberg on "Life Zones in the Rocky Mountains"; Fred J. Seaver on "Bermuda Fungi," and Karl F. Kellerman on "Cooperation in the Control of Plant Diseases."

Following tea at the mansion, an inspection of the nurseries, arboretum, propagating houses, conservatory range and the Bronx River valley as far as Hemlock Forest will be made. A smoker at the Faculty Club, Columbia University, will be held in the evening. On Friday, September 10, the entire day will be devoted to a visit to the pine barrens of New Jersey, under the guidance of the field committee of the Torrey Botanical Club. On Saturday the delegates will visit the Brooklyn Botanic Garden.

SCIENTIFIC NOTES AND NEWS

Dr. Jacques Loeb, of the Rockefeller Institute for Medical Research, has been elected a foreign fellow of the Linnean Society, London.

Professor W. A. Bone has been elected president of the chemistry section of the British Association at the meeting held in Manchester this week, taking the place of Professor H. B. Baker who is unavoidably prevented from attending the meeting.

The South African medal, founded by the British Association in 1905, for scientific research in South Africa, was awarded at the Pretoria meeting of the South African Association, to Mr. C. P. Lounsbury for his entomological investigations.

Professor J. C. Arthur, who has been in college and experiment-station work for nearly forty years, and for the last twenty-eight years has held the chair of professor of vegetable physiology and pathology in Purdue University and chief of the botanical department of the Indiana Agricultural Experiment Station, retires on the first of September to become professor emeritus of botany in the same institution under the provisions of the Carnegie Foundation. He will continue the researches on plant rusts which have been in progress for a number of years. His successor in the experiment station will be Professor H. S. Jackson, of Corvallis, Ore.

The *Experiment Station Record* states that there has been held at the Iowa College of Agriculture a special convocation in honor of those members of the faculty who have been in service for at least a quarter of a century. The guests of honor were Vice-president E. W. Stanton, in service since 1874; General J. R. Lincoln, commandant, Henry Knapp, secretary, both in service since 1883; A. A. Bennett, professor emeritus of chemistry, in service since 1885, and Dr. L. H. Pammel, professor of botany and botanist, in service since 1889.

It is stated in *Nature* that the sum of £140 has been given to the Royal Society of Arts by Mr. R. Le Neve Foster for the purpose of founding a prize in commemoration of his father, Mr. Peter Le Neve Foster, who was secretary of the society from 1853 to 1879. The council has decided to offer the prize (consisting of £10 and the society's silver medal) for a paper on "Zinc: Its Production and Industrial Applications."

The Vienna Academy of Sciences has made a grant of about $800 to Professor R. Poech to enable him to conduct anthropological researches among the various races comprising the Russian prisoners of war.

It is stated in *Terrestrial Magnetism* that M. Lecointe, director of the Royal Observatory of Belgium, at Uccles, near Brussels, is at

present interned in Holland. He had served in the war as a major of artillery in the Belgian army, and took part in the retreat from Antwerp.

DR. WARMBOLD, of Berlin, has been appointed rector of the Agricultural School at Hohenheim.

PROFESSOR SCHMIDT, of Marburg, has been awarded the doctorate of engineering by the Brunswick School of Technology, in recognition of his services to pharmaceutical chemistry.

PROFESSOR OPPENHEIM, of Berlin, has been made an honorary member of the Buenos Aires Society for Psychiatry and Neurology.

HENRY G. KNIGHT, dean of the Wyoming College of Agriculture and director of the station, O. L. Prien, veterinarian, and J. E. McWilliams, acting animal husbandman, have been granted a year's leave of absence beginning September 1, to be spent in study at the University of Illinois, Northwestern University and the Michigan Agricultural College, respectively. President C. A. Duniway, of the university, will act as director of the station during this period.

WE learn from *Nature* that a munitions inventions branch of the British ministry has been constituted, with Mr. E. W. Moir as comptroller. The branch will have the duty of considering projects for inventions relating to munitions for warfare on land or matters appertaining thereto. The comptroller and staff of the branch will be assisted in their work of examination, and, if thought necessary, in the investigation and development of any projects that may be considered worthy of being developed, by a panel of honorary scientific and other experts. The following have accepted Mr. Lloyd George's invitation to act on this panel: Colonel Goold Adams, Mr. Horace Darwin, Mr. M. Duckham, Mr. W. Duddell, Dr. S. Z. de Ferranti, Dr. R. T. Glazebrook, Sir R. Hadfield, Dr. J. S. Haldane, Colonel N. B. Hefferman, Sir A. Kennedy, Mr. F. W. Lanchester, Dr. A. P. Laurie, Professor Vivian B. Lewes, Mr. M. Longridge, Mr. W. H. Maw, Sir Hiram Maxim, Captain Moore, Sir H. Norman, Mr. F. G. Ogilvie, Major-General G. K. Scott-Moncrieff, Mr. W. Stokes, Mr. J. Swinburne, Sir J. J. Thomson, Mr. A. J. Walter, Mr. C. J. Wilson.

THE president of the British board of agriculture and fisheries has appointed a committee consisting of Lord Middleton, chairman, Mr. Henry Chaplin, Sir Ailwyn Fellowes, the Hon. Alexander Parker, Major Sir M. Burrell, Bart., Sir G. Greenall, Bart., and Captain M. S. Adye to consider and advise the board as to the steps which should be taken to secure the production and maintenance in England and Wales of a supply of horses suitable and sufficient for military purposes. Mr. E. B. Wilson, of the board of agriculture and fisheries, has been appointed secretary of the committee.

DR. HERMAN FISCHER, of the German Hospital, New York, will head an expedition, consisting of twenty surgeons and nurses, to be sent under the auspices of the "American Physicians Committee" to Germany and Austria. The expedition acts in cooperation with the American Red Cross.

JULIUS VON PAYER, the distinguished polar explorer and artist, has died in Vienna at the age of seventy-three years. He was a member of the Austrian Antarctic expedition which in 1871 discovered Franz Joseph Land.

PROFESSOR GUIDO GOLDSCHMIEDT, director of the first chemical institute of the University of Vienna, well known for his work in organic chemistry, died, after a prolonged illness, on August 6, at the age of sixty-five years. Professor and Mrs. Goldschmiedt visited this country in 1912, at the time of the Eighth International Congress of Applied Chemistry, and made many friends in scientific circles.

THERE have been killed in the war Dr. Emil Lask, associate professor of philosophy at Heidelberg; Dr. Waldemar Conrad, docent for philosophy at Halle; Dr. Hugo Schultze, scientific assistant in the Reichsanstalt; Professor Bartel, director of the Archeological Institute of Frankfort; Dr. Deimler, docent in the Munich School of Technology, and Dr. O. Bondy, docent for gynecology in the University of

Breslau, and Dr. Karl Muenk, chemist in the Prussian Geological Survey.

It is said that the Nobel prizes for the present year will not be awarded. From next year the prizes will be reduced by about $5,000, representing the amount of the new Swedish defence tax.

In a letter to the London *Times*, Sir Henry E. Roscoe, who was president of the British Association for the Advancement of Science when it met in Manchester twenty-five years ago, writes: "The pressing importance of the organization of scientific method and research has now become recognized both by government and the public. Your columns have been generously open to distinguished scientific opinion as to this necessity. The more important scientific societies are busily engaged in forming committees of their members to aid government departments, whilst these latter have called in specially qualified experts from all branches of scientific inquiry to aid ministers and departmental officials in carrying out the new duties which the present position entails. So far, so good. But more remains to be done. A general conference of the leaders and workers in British science needs to be added. Of the importance of such conference and of the ensuing personal contact at the present moment there can not be two opinions. Such an opportunity will present itself at the forthcoming eighty-fifth meeting of the great annual Congress of British Science to be held in Manchester on September 7. This year the meeting will be stripped of all but its scientific activities, and these, if properly utilized, can not fail to be of essential use to the country, for it is by the personal intercourse of scientific men of all kinds that stimulus is aroused and progress made. It is, therefore, confidently expected that at the September meeting every branch of British scientific activity will be fully represented, so that the expression of their united opinion may be given with no uncertain voice."

The board of directors of the American Institute of Electrical Engineers, as we learn from the *Electrical World*, held in New York on August 10, its first meeting of the administrative year which began on August 1. President John J. Carty announced his appointments on the various institute committees for the administrative year. The chairmen of the committees appointed are as follows: Finance, Mr. J. Franklin Stevens, Philadelphia, Pa.; library, Dr. Samuel Sheldon, Brooklyn, N. Y.; meetings and papers, Mr. L. T. Robinson, Schenectady, N. Y.; editing, Professor H. H. Norris, New York; board of examiners, Dr. A. S. McAllister, New York; sections, Mr. H. A. Hornor, Philadelphia, Pa.; standards, Professor C. A. Adams, Cambridge, Mass.; code, Mr. Farley Osgood, Newark, N. J.; law, Mr. G. H. Stockbridge, New York; power stations, Mr. C. F. Uebelacker, New York; transmission, Mr. P. H. Thomas, New York; railway, Professor D. C. Jackson, Boston, Mass.; protective apparatus, Dr. E. E. F. Creighton, Schenectady, N. Y.; electric lighting, Dr. Clayton H. Sharp, New York; telegraphy and telephony, Mr. G. M. Yorke, New York; industrial power, Mr. David B. Rushmore, Schenectady, N. Y.; use of electricity in marine work, Mr. C. S. McDowell, New York; electrochemics, Professor A. F. Ganz, Hoboken, N. J.; electrophysics, Mr. John B. Whitehead, Baltimore, Md.; records and appraisals of properties, Mr. Philander Betts, Newark, N. J.; educational, Professor V. Karapetoff, Ithaca, N. Y.; public-policy committee, Mr. Calvert Townley, New York; development of water-powers, Mr. Calvert Townley, New York; patents, Mr. Ralph D. Mershon, New York; membership, Mr. W. A. Hall, Lynn, Mass.; historical museum, Mr. T. C. Martin, New York; United States national committee, International Electrotechnical Commission, Mr. C. O. Mailloux, New York; relations of consulting engineers, Dr. L. B. Stillwell, New York; code of principles of professional conduct, Professor George F. Sever, New York; hazards from lightning, Professor Elihu Thomson, Swampscott, Mass.; reserve corps of engineers, Mr. Bion J. Arnold, Chicago, Ill.; constitutional revision, Mr. Bancroft Gherardi, New York. Representatives were also appointed on various joint committees and other bodies.

OWING to the increasing demand, on the part of astronomers, chemists and physicists, for accurate values of the wave-lengths of the lines in the spectra of iron and other elements, the Bureau of Standards has taken up the work of determining standards of wave length. This work is being done in accordance with the recommendations of the International Wave-length Committee. The spectrograms were obtained in Marseilles in the laboratories of Buisson and Faby, the pioneers in this work. The plates were measured at the Bureau of Standards. This is rather a difficult region of the spectrum to observe, lying entirely in the ultra-violet. Apparatus necessary to do this work has recently been installed in the Bureau of Standards, and wave-length determinations of the highest accuracy are being made throughout the spectrum, including those rays which are too short to be visible and also those which are longer than any that the eye can see. A pamphlet upon this subject has just been issued as Scientific Paper No. 251, copies of which may be obtained without charge from the Bureau of Standards, Washington, D. C.

THE Paris correspondent of the London *Times* writes that the Pasteur Institute presents rather a dead appearance at present. Most of the laboratory assistants have departed for the front, where, indeed, two doctors have met their death. There has been in consequence a slackening of experimental work, as well as a corresponding diminution in the running expenses of the establishment. A large part of the famous menagerie has disappeared. Quantities of rabbits, rats and mice still exist, but the ourang-outangs, amongst others, have ceased to be, as they were expensive to keep as prospective fields for experiment after the war. A large department of the institute is now engaged in cultures for serums for use on the battlefield.

THE annual grants made by parliament specifically for scientific investigations and related services amount to about £100,000, and the details of the estimates for 1915–16 are shown in the subjoined table which we reproduce from *Nature*.

Royal Society:	
(*i*) (*a*) Scientific Investigations	£4,000
(*b*) Scientific Publications	1,000
(*ii*) Magnetic Observatory at Eskdalemuir	1,000
(*iii*) National Physical Laboratory	7,000
(*iv*) Aeronautical Section of the National Physical Laboratory	9,425
Meteorological Office	22,500
Royal Geographical Society	1,250
Royal Academy of Music	500
Royal College of Music	500
Marine Biological Association of the United Kingdom	500
Royal Society of Edinburgh	600
Scottish Meteorological Society	100
Royal Irish Academy	1,600
Royal Irish Academy of Music	300
Royal Zoological Society of Ireland	500
Royal Hiberian Academy	300
British School at Athens	500
British School at Rome	500
Royal Scottish Geographical Society	200
National Library of Wales	8,200
National Museum of Wales	17,300
Solar Physics Observatory	3,000
British Academy	400
School of Oriental Studies	1,500
North Sea Fisheries Investigation	1,250
Transantarctic Expedition, 1914–15	5,000
Edinburgh Observatory	1,657
	£90,582

THE Dominion of Canada has, as we learn from the *Experiment Station Record*, appropriated $3,308,000 for agriculture for the year 1915–16, $785,000 of which is for the maintenance of experiment farms, $550,000 for the development of the live-stock industry, $540,000 for the "health of animals," $280,000 for exhibitions, $275,000 for the administration and enforcement of the meat and canned-foods act, and $200,000 for the encouragement of cold-storage warehouses. The appropriation includes $150,000 for the development of the dairying industries and the improvement in transportation, sale and trade of food and other agricultural products, $140,000 to enforce the seed act, $113,000 for the fruit branch, $100,000 for the administration and enforcement of the destructive insect and pest act, $25,000 for the administration and carrying out of the provisions of the agricultural-in-

struction act, $25,000 for the National Biological Laboratory, $20,000 to assist in the maintenance of the International Institute of Agriculture, $20,000 for entomology, $15,000 for publications, and $70,000 for exhibits, repairs, etc. A further $900,000 is allotted under the agricultural-instruction act. The new building at the Ontario Veterinary College is now in use. It is a five-story brick structure with 134-foot frontage and 900,000 cu. ft. capacity, and cost about $250,000. It contains several large laboratories, an assembly room seating 500, an infirmary for horses, offices, etc. At the Nova Scotia Agricultural College, a new science building 130 by 50 feet, with laboratories for chemistry, soil physics, entomology, plant diseases and home economics, an assembly hall seating 250, offices, classrooms, etc., is nearing completion.

THE Forest Service has sent a warning that more than half of the forest fires in the United States are due to carelessness or other preventable causes, starting from campers, railroad locomotives, brush burning, incendiaries and sawmills. This statement is based on an analysis of statistics compiled from the forest records of the last season, when more than 7,000 fires were reported on national forests alone and approximately 10,000 on state and private holdings in the eighteen states which received federal cooperation in fire protection under the Weeks law, namely, Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Maryland, West Virginia, Kentucky, Michigan, Wisconsin, Minnesota, South Dakota, Montana, Idaho, Washington and Oregon. Forest fires destroy millions of dollars' worth of timber and other property every year, and in some years cause considerable loss of life. It has been estimated from the best information obtainable that forest fires last year burned over an area of approximately 6,000,000 acres with a total loss of at least $9,500,000.

Nature states that the Ipswich Museum has for some time past made a very strong feature of the department of prehistoric archeology, and has collected extensively from the uniquely rich district of East Suffolk. The museum collections now include a large and representative series of pre-Paleolithic and Paleolithic flint implements, and also numerous examples of specimens referable to the later Cave and Neolithic periods. Among the later additions may be noted a large series of implements, bones, etc., from the Grimes Graves flint mines, Mousteir flints from Baker's Hole pit in the Thames Valley, and implements of different ages presented by Dr. A. E. Peake and Rev. H. G. O. Kendall. The museum authorities have just purchased the entire series of local specimens, and the Paleolithic implements from the Dovercourt gravels collected by the late Lieutenant-Colonel Underwood, of Ipswich, and these make a very valuable addition to the collections. The skeleton of the Neolithic (or early Bronze age) youth found with an ornamented drinking vessel by Mr. Reid Moir at Wherstead, near Ipswich, is now on exhibition, together with other interesting human skulls, and the remains of extinct animals.

THE Bureau of Standards has published a paper entitled "Characteristics of Radiation Pyrometers," giving the results of careful study of this type of temperature measuring instrument. Such a study was considered urgent on account of the extensive use of radiation pyrometers in the technical industries. These instruments are widely used in the temperature control of the various processes involved in iron and steel manufacture, alloy foundry work, glass, ceramics and brick manufacture, smelting, gas works, steam generation, lamp manufacture, etc. Many of the instruments examined show different temperature readings for different focusing or sighting distances. Errors thus occasioned may amount to several hundred degrees. The effect of dirt upon the lenses and mirrors is of serious importance. The question as to whether the pyrometer absorbs all the heat radiation falling upon it is discussed, and the theory of the instrument, and the connection of the behavior of the pyrometer with the theoretical radiation laws are given. The Bureau receives a large number of these instruments for test and standardization, from various

technical industries located throughout the country. Heretofore this testing required about three days for a single instrument on account of the difficulty in heating a furnace to an exactly uniform temperature. A new method has now been developed which permits a satisfactory standardization of a radiation pyrometer within one hour. Many suggestions are given for minimizing the errors to which the pyrometer is subject, and it is shown that this type of instrument suitably designed, adequately calibrated, and correctly used, is a trustworthy pyrometer having many advantages over other types of temperature measuring devices, both for scientific and technical use.

THE government's herd of buffalo on the Wichita National Forest, in Oklahoma, which is also a federal game preserve, has been increased by the arrival of ten calves, according to a report received by the Forest Service from the supervisor in charge. The herd, which now comprises sixty-two specimens of the almost extinct bison, is in good condition, says the supervisor, and promises to continue increasing at a rapid rate. Eight of the calves are females, bringing the number of heifers and cows up to thirty. The bulls number thirty-two and have been placed by themselves in a pasture which has just been fenced in for them. Three years ago the buffalo herd on the Wichita Forest was little more than half as large as it is now. It is said that the other game animals in the preserve, including the elk and antelope, also are increasing, due to the protection afforded, not only against hunters, but against wolves, wild cats and other predatory animals, which committed serious depredations from the establishment of the preserve in 1905 until measures were taken to stop them. In protecting the game from predatory animals, the wardens and forest officers are also promoting the interests of local stockmen, who graze several thousand head of cattle on certain allotted areas within the preserve.

Nature says of the Harvard College Observatory: "Anything concerning this famous institution can not fail to be of interest, and thus we welcome a reprint from the *Harvard Alumni Bulletin*, March 10, 1915, of two articles, one by the director, Professor Pickering, and the other over the initials 'J. D. M.' dealing with the observatory and its work respectively. Founded in 1840 by W. C. Bond, with the help of thirty subscriptions of £20 each, the endowments now amount to £200,000, and the annual income exceeds £10,000, yet, we are told, 'there has never been a time . . . when funds . . . were needed more than they are today.' In addition to the well-known Arequipa Station in Peru, where the 24-in. photographic doublet has been mounted, a station in Jamaica has recently been founded for visual work. No fewer than seventy complete quarto volumes of *Annals* have been published and eight others are in preparation, whilst about 200 circulars have been issued. Concerning the progress of the Draper Catalogue, we are informed that down to March 1, 1915, Miss Cannon had classified no fewer than 188,350 stellar spectra."

UNIVERSITY AND EDUCATIONAL NEWS

CAPTAIN C. F. BALLEINE, fellow of Exeter College, Oxford, who was killed in action on July 2, bequeathed £1,000 to the college.

ACCORDING to the London *Times* Sir A. H. Church has bequeathed to fellows of Lincoln College, Oxford, £500; to the Waynflete professor of mineralogy in the university £100 for the purchase of apparatus and mineral specimens, together with the testator's optical instruments, mineral specimens and chemical apparatus; and £100 to the curators of the Ashmolean Museum.

DR. T. C. HEBB, professor of physics at the Northern State Normal School, Marquette, Michigan, has been granted his sabbatical year and will devote it to study at Columbia University.

NEW appointments at Bedford College, London, as we learn from *Nature*, include: assistant lecturer in physics, Miss M. O. Saltmarsh; demonstrator in physics, Miss M. Baxter; demonstrators in physiology, Miss Hartwell and Miss Tweedy; demonstrator in geology, Miss I. Lowe.

Dr. H. G. Earle has been appointed to the chair of physiology in the University of Hongkong.

DISCUSSION AND CORRESPONDENCE

MASS AS QUANTITY OF MATTER

That the words "quantity of matter" are of service in explaining the significance of "mass" in dynamics has been assumed either explicity or tacitly by many authorities, including Newton, Maxwell, Kelvin, Tait and Clifford, and this view is obviously held by several of those who have contributed to the recent discussion in Science. There are, however, those who dissent from this view,[1] maintaining that the word mass as used in dynamics has no meaning except that given to it by the "law of acceleration" (Newton's second law), and that the statement that "the mass of a body is a measure of its quantity of matter" contributes nothing to our understanding of the definition. My present object is to call attention to a consideration which appears to be lost sight of by those who take this latter position. This consideration, stated briefly, is that *the mass of a body is distributed in a perfectly definite way among the individual portions of matter of which the body is composed.*

[1] The dissenting view is vigorously advocated by Professor Huntington in his latest letter (Science, July 30, 1915). It should be noted that this question is aside from the question whether mass should appear in the fundamental equations. Whatever definition of mass may be adopted, the fact remains that the quantity ordinarily called mass is a part of the fundamental data of dynamics. That Professor Huntington's formulation of principles obscures this fact is my chief reason for dissenting from it. Further discussion of this point by me would, however, be a reiteration of what has been said in a former communication (Science, April 23, 1915). Any reader who is interested in Professor Huntington's reference to my text-book on theoretical mechanics may find by consulting the book that the explanation of the laws of motion contained in it is substantially that which I have recently favored in the pages of Science; but it is my present belief that the notion of quantity of matter might have been used more effectively in this book, as well as in most other text-books that are known to me.

Dynamics deals with the motions of bodies. By a body we mean any connected aggregate of matter. Without attempting to define matter, we recognize the applicability to it of the notions that *the whole is greater than any part* and *the whole is equal to the sum of its parts.* These are quantitative notions; and it will be seen that they are an essential part of the notion of *mass* which we habitually use in interpreting the second law of motion.

Consider the following proposition:

I. *If two bodies be acted upon by equal forces, the body having the greater mass will have the lesser acceleration.*

According to one view this is merely an arbitrary definition of the meaning of greater and less as applied to mass; *i. e.,* the statement that "the mass of a body A is greater than that of a body B" is held to mean nothing more than that "if A and B be acted upon by equal forces the acceleration of A will be less than that of B." If, however, we are to regard proposition I. as having any application to actual physical bodies, it is easy to show that it is not a mere definition, but a partial expression of a physical law, enabling us in certain cases to make predictions. Thus, suppose material to be removed from a body A, leaving a body B; we know that, if a certain force be applied to A and an equal force afterward to B, the acceleration of B will be greater than that of A; and the truth of this is recognized because we know that B contains less material than A. That is, in applying I. to this case we associate with *mass* the notion of *quantity of matter.*

Consider now the following more definitely quantitative proposition:

II. *If different bodies are acted upon by equal forces, the resulting accelerations are in the inverse ratios of the masses of the bodies.*

The interpretation we put upon this proposition becomes evident from a consideration of particular cases.

As a first illustration let A be a body which, when acted upon by a force F, has the acceleration a; and suppose A to be divided into two

bodies B and C and that forces equal to F, applied to B and C, cause accelerations a', a''. We recognize the truth of the following statements about the values of a' and a'':

Both a' and a'' are greater than a.

If one of the accelerations a', a'' is less than $2a$ the other is greater than $2a$.

If a' and a'' are equal, each is equal to $2a$.

The accelerations satisfy the equation $1/a' + 1/a'' = 1/a$. (This of course includes the three preceding statements.)

These statements are consequences of II.; but the reason we recognize this is because we recognize that A contains more matter than either B or C, and that the sum of the quantities of matter of B and C is equal to that of A. That is, in interpreting II. we regard *mass* as a measure of *quantity of matter*.

As another illustration, let A and B be any two distinct bodies such that when equal forces are applied to them the acceleration of A is less than that of B. Proposition II. tells us that the mass of A is greater than that of B; but is there any reason for saying that A *contains more matter* than B? There is this reason: We know that, by removing from A some quantity of matter, there will remain a body A' such that, if equal forces be applied to A' and B, their accelerations will be equal; or by adding to B some quantity of matter there will be produced a body B' such that, if equal forces be applied to A and B', their accelerations will be equal. Moreover, we know that the matter which must be taken from A to produce A', and that which must be added to B to produce B', have equal masses m as tested by II.; and that if the accelerations of A and B due to equal forces F are a' and a'', a body of mass m acted upon by a force F would have an acceleration a such that $1/a = 1/a' - 1/a''$. These facts are all recognized as consequences of II. because we regard *mass* as therein used to be a measure of *quantity of matter;* they would not follow if our notion of mass were derived wholly from proposition II. itself.

The significance of mass in the second law of motion is sometimes stated in the following form:

III. *The forces required to give equal accelerations to different bodies are proportional to their masses.*

It is easy to cite illustrative cases showing that in applying this proposition also we interpret mass as a measure of the matter of which bodies are composed. Thus the statement that "body A has three times the mass of body B" means more than that "body A requires three times as much force as body B to give it a specified acceleration"; it means that the material contained in body A might be made into three bodies, each of which would require the same force as body B to give it a specified acceleration.

It is of course true that an important part of the import of propositions II. and III. consists in giving precision to the definition of mass. But the illustrations which have been given show that the preliminary definition of mass as quantity of matter is not without important meaning, and serves a useful purpose in explaining the significance of mass in the laws of motion.

L. M. Hoskins

Stanford University,
August 5, 1915

IS SIVAPITHECUS PILGRIM AN ANCESTOR OF MAN?

In the "Records of the Geological Survey of India" for February, 1915, Dr. Guy E. Pilgrim has described the fossil anthropoids of India, including several new forms of great interest from the Lower, Middle and Upper Siwaliks. Through the kindness of Dr. Pilgrim the American Museum of Natural History has received casts of his types and principal specimens of Siwalik anthropoids, consisting of fragments of jaws and isolated molars. These casts, together with Dr. Pilgrim's excellent illustrations, have enabled the writer to make a critical comparison of the extinct Indian anthropoids with the existing anthropoids and with recent and extinct races of man.

Pilgrim describes several new species of *Dryopithecus*, a genus characteristic of the Upper Miocene of Europe. Its known range is thus extended to the Upper Miocene of

India. One of these Indian species of *Dryopithecus* (*D. punjabicus*) is apparently related to the gorilla; another (*D. giganteus*), perhaps to the chimpanzee; an allied genus, *Palæosimia,* bears a significant resemblance to the orang; a fourth type, *Palæopithecus sivalensis* Lydekker, is a synthetic form with resemblances to the gorilla, chimpanzee and gibbon. In the reviewer's opinion all these are more primitive than any of their modern relatives and indicate that in the Upper Miocene northern India was not far from the center of evolution of the anthropoids and man.

The important genus and species *Sivapithecus indicus,* from the Lower and Middle Siwaliks, rests upon fragments of the lower jaw and dentition. From these Dr. Pilgrim has attempted a restoration of the lower jaw that shows a subhuman divergence of the opposite rami and a very short, man-like symphysis. Pilgrim regards this genus as in or near the ancestral line of *Homo sapiens.*

The reviewer regrets to report that after a careful study of the evidence he believes Dr. Pilgrim has erred in attributing the abovementioned human characteristics to *Sivapithecus,* the jaw of which, in the reviewer's opinion, should be restored rather after the pattern of the female orang jaw. The evidence for this conclusion will be given elsewhere. The reviewer would also dissent from Dr. Pilgrim's allocation of *Sivapithecus* to the Hominidæ, preferring to place it by definition in the Simiidæ, since it had ape-like canines and front premolars, and, as the reviewer interprets the evidence, also an ape-like symphysis.

William K. Gregory

CASTLE AND WRIGHT ON CROSSING OVER IN RATS

In a recent number of Science (August 6) Castle and Wright describe a case of linkage in rats. One point of general interest indicated by their results is not pointed out by these authors; namely, that crossing over occurs in both sexes. This conclusion depends on the appearance, in F_2 of their cross (red-eyed yellow by pink-eyed yellow), of doubly recessive rats. They state that two such rats appeared, this being inferred from the fact that two of the F_2 pink-eyed yellows, when mated to red-eyed yellows of stock, "produced only red-eyed (yellow) offspring." This result must mean either that these two rats were not sufficiently tested, and were not really double recessives; or else, if they were double recessives, that there had been crossing over in both sexes of F_1 rats. As to the first possibility, the crucial point is the number of red-eyed offspring produced in the test mating. Unless this number was large enough to completely rule out the possibility of the F_2 pink-eyed rats having been only heterozygous for the red-eye factor, the second alternative is not necessarily true. If the second possibility be true it follows that the relation of crossing over to sex determination is different here from that in *Drosophila* (Morgan) and the silkworm moth (Tanaka), where no crossing over occurs in the sex which is heterozygous for the sex factors[1] (male in *Drosophila,* female in the silkworm moth). Since the evidence from sex-linkage and cytology shows that in several mammals (man, cat, etc.) the male is heterozygous for the sex factor, we should expect, if the relation to crossing over is a general one, that no crossing over would take place in the male mammal.

A. H. Sturtevant

August, 1915

SCIENTIFIC BOOKS

A Monograph of the Existing Crinoids. Volume 1. *The Comatulids:* Part 1. By Austin Hobart Clark, Assistant Curator, Division of Marine Invertebrates, United States National Museum. Bulletin 82. Washington, Government Printing Office. 1915. 4to. Pp. vi + 486; with 513 text-figures, and 17 plates.

The last general treatise upon the Recent Crinoids is contained in the monumental volumes of P. Herbert Carpenter upon the "Stalked Crinoids and the Comatulæ," published in 1884 and 1888 by the British government as part of the results of the voyage of H. M. S. *Challenger.* Although based chiefly

[1] See Sturtevant, A. H., *Amer. Nat.*, XLIX., 1915.

upon the *Challenger* collections, these volumes constituted a thorough monograph of the group as it was known at those dates. During the ensuing quarter of a century extraordinary activity in marine exploration has prevailed in all the oceans, resulting in an enormous increase of material for study—both in the way of specimens, and of accurate records of occurrence and distribution, by which the influence of depth, temperature and ocean currents upon the growth and modification of crinoid faunas can be studied in a manner not hitherto possible. New species and genera have thus been brought to light to an extent wholly unexpected. With this great multiplication of new forms, it has become increasingly evident to those interested in the subject that the criteria employed for discrimination of the Fossil Crinoids are only applicable in a limited degree to the Recent, and that some new method of treating the latter is required in order to adequately deal with the new facts. The practical working out of such a method is perhaps the most important general result of Mr. Clark's researches; this will be fully developed in his monograph, of which the present volume is the introductory part, to be followed by others treating systematically the genera and species of the Comatulids and Stalked Crinoids.

Much of the work to be embodied in the subsequent volumes has already been done, and the results published in preliminary form in a series of papers appearing in various American and foreign journals during the past eight years, which give evidence of the extraordinary energy with which the author has prosecuted his studies. These publications, beginning with the description of the new genus *Ptilocrinus* in June, 1907, now amount to a total of 114 papers, of which 23 were issued in journals of England, Denmark, France, Holland, Germany, Monaco, India, New South Wales and western Australia. Some of these are really treatises in permanent form—notably that upon the "Crinoids of the Indian Ocean," a fine quarto volume of 325 pages and 59 figures, published in 1912 by the trustees of the Indian Museum at Calcutta; this was based upon the collections made during a number of years by the Royal Indian Marine Survey steamer *Investigator*, and placed by the authorities of the museum in Mr. Clark's hands for description. Another quarto work of 209 pages and 10 plates is "Die Crinoiden der Antarktis," published in Germany upon the collections made by the steamer *Gauss*, of the Deutsche Sudpolar-Expedition, which were sent to the author for investigation. A paper upon a collection of crinoids from the Zoological Museum of Copenhagen was published in the "Vidensk Medd. fra den Naturhist. i Kjöbenhaven," 1909; one of 100 pages on the "Recent Crinoids of Australia," in the Memoirs of the Australian Museum at Sydney, in 1911; and another in the same year on the "Crinoidea" of the Hamburg Southwest Australian Expedition was published as Band III., Lieferung 13, of the scientific results of that expedition.

Of the remaining 91 papers published in America, the greater part have appeared in the Proceedings of the U. S. National Museum. Out of the total number of papers, 69 have been upon collections examined. Some idea of the wide range of the researches upon which this monograph is founded may be had from an enumeration of the collections, and of material from expeditions which have been studied. In addition to the already large collections of the United States Bureau of Fisheries, and of the National Museum, accumulated by the dredgings of various Coast Survey and Fisheries vessels, including the recent cruises of the *Albatross* in the Pacific Ocean, the following foreign museum and special collections have been placed at Mr. Clark's disposal and sent by their owners to Washington for his use: Zoological Museum, Copenhagen; Hamburg Museum, containing the types of Hartlaub's species; Museum für Naturkunde, Berlin, containing the type material of Johannes Müller's classical works upon the recent crinoids; Indian Museum, Calcutta; Australian Museum, Sydney; Western Australian Museum and Art Gallery, Perth; Sv. Gad collection from Singapore; Svensson collection from East Asia, Copenhagen. Also the

material collected by the following special expeditions, which has been sent to Mr. Clark from time to time for description: *Ingolf* (Danish), Greenland and Northwest Atlantic; Danish expeditions to Siam and to the Danish West Indies; *Investigator* and *Golden Crown* (Indian), Indian Ocean; *Helga* (Irish), West Ireland; *Siboga* (Dutch), East Indies; *Gauss* (German) Antarctic; *Gazelle* (German), East Indies and Australia; *Golden Hind* (Japanese); *Endeavor* (Australia). It may be remarked in passing that in consideration of the work done upon the collections of these various expeditions, a liberal portion of the specimens has in all cases been left in Mr. Clark's hands, which have been placed by him in the National Museum; and that as a result of these accessions this museum now possesses a far more extensive and varied collection of the Recent Crinoids than any other institution in the world.

The author's method of treatment, and the classification proposed by him, have gained general acceptance by the leading authorities upon the recent crinoids, and his new genera have been adopted in practise by Dr. Hubert Lyman Clark, of the Museum of Comparative Zoology, Cambridge; and in Europe by Dr. Theodor Mortensen, of Copenhagen; Professor Ludwig Doederlein, of Strassburg; Dr. August Reichensperger, of Bonn; Professors Rene Koehler and C. Vasey, of Lyons. Dr. Mortensen and Professor Doederlein turned over the extensive Danish and German collections under their control to Mr. Clark for description; and the magnificent collections made by the Marine Survey steamers of the Indian government were placed in his hands for study and publication upon the suggestion of Dr. F. A. Bather, the distinguished crinoid authority of the British Museum.

In the way of technical equipment for this work Mr. Clark has unusual advantages. In addition to a general zoological training he had the benefit of experience in collecting birds and insects in Europe, the West Indies and South America. After this he served as naturalist upon the steamer *Albatross* of the U. S. Fish Commission during a cruise of some 15,000 miles, prosecuting extensive and continual dredgings along the coasts of Alaska, the Aleutian Islands, Kamschatka, Japan and Korea, and returning *via* the Hawaiian Islands. On these voyages vast numbers of crinoids were taken, and the personal knowledge of their occurrence and distribution thus gained by the future author enlisted his interest in the intensive study of these organisms, to which he has since given his chief attention. By way of further necessary preparation Mr. Clark in 1910 visited the chief museums of Europe, and studied at first hand all the collections of historic interest containing types and other material used by previous authors from Lamarck and Müller to those of the present day, including the specimens from the *Challenger* and other British exploring steamers which had been studied by Sir Wyville Thomson and the two Carpenters. Detailed reports of the examination of several of these collections were published in the *Proceedings* of the National Museum, and the Smithsonian Miscellaneous Collections, and in journals of the museums visited.

The present volume, as already stated, is to a large extent introductory, and is chiefly devoted to the comatulids, or unstalked crinoids. After a very full historical introduction, a table of the terms employed in the description of a comatulid, and a discussion of the relative status of the crinoids as a zoological unit, there is an instructive explanation of the proper way to study a comatulid for purpose of identification. Then follows an elaborate treatise upon the structure and anatomy of the crinoids, in the course of which many new facts ascertained from dissections and other observations by the author are brought out. The illustrations, embracing a total of 602 figures, are prepared with great care for the purpose of definite information. With some experience in this line as to the fossil crinoids, the present writer is able to bear testimony to the immense labor involved in the preparation of these figures, especially those illustrating the minute anatomy of the crinoid skeleton, drawn by the author himself. No such lucid representation of these structures for the re-

cent crinoids generally has ever been given before.

There is not space to review the questions of zoological relationships discussed—some of which are speculative, and will doubtless meet with criticism—nor the many new discoveries touching the structure and characters of the crinoid organism, which testify to the industry of the author. Among the more general conclusions to which these researches have led, the following may be mentioned:

1. The Crinoids of the recent seas are far more numerous, both in individuals and in species, than is commonly supposed, and their relative importance does not fall short of that of the other echinoderm groups.

2. The Crinoids, after a paleontological record almost without a parallel for duration and for variety in development, are represented in the recent seas chiefly by two highly aberrant types, viz: (1) the Pentacrinites, which have departed widely from their prototypes by enormously increasing the length of the column through the indefinite reduplication of the first stem joint, or proximale; and (2) the Comatulids, which have departed just as widely by discarding the column and compressing what is virtually the entire column of the pentacrinites within the compass of a single highly cirriferous proximale. Thus while the two groups are parallel to each other, and are descended from the same ancestral stock, and represent the same phylogenetic stage, during their development they have diverged from their phylogenetic mean in exactly opposite directions; and both groups are therefore far removed from the direct line representing the progressive development of the class.

3. These two aberrant types dominate the recent seas to such a degree that in comparison with them all the other types become relatively insignificant. The comatulids, although in their relation to the fossil crinoids merely an inconspicuous family, far outnumber all of the other existing crinoids taken together, at the same time extending through a much wider geographical, bathymetrical and thermal range. They exist in a vast array of diverse forms, none of which depart in any great degree from the general structure of the group, so that their classification necessitates the creation of numerous subfamilies, and families, and higher groups, which are not systematically comparable to similar groups in the stalked crinoids.

4. Among the Recent Crinoids the calyx, usually reduced to insignificant proportions, is of comparatively little systematic value—the classification being placed chiefly upon the column (or homologous structures), and the proximal pinnules. This is, broadly speaking, the reverse of the conditions in the fossil forms, and this fact involves the recognition of characters for the differentiation of species and genera wholly different from those employed in dealing with the fossils. The application of these criteria to the study of the collections and material above mentioned has resulted in the proposal of nearly 100 new genera, and the description of several hundred species new to science, among the comatulids alone, the systematic treatment and illustration of which are to follow in a succeeding volume.

5. The author believes the echinoderms to be a highly abberrant offshoot from a primitive crustacean stock, and that they are far from being the anomalous creatures they are commonly considered.

The thanks of all students of the echinoderms are due to the authorities of the National Museum for their liberality in facilitating the publication of the results of these researches in so thorough and comprehensive a manner, and in thus giving to the scientific public a work which is destined to take rank with the great monographs following the *Challenger* Expedition—a series which in its entirety stands as one of the finest contributions to the knowledge of marine zoology ever produced.

Frank Springer

THE PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The eighth number of Volume 1 of the *Proceedings of the National Academy of Sciences* contained the following articles:

1. *Weber's Law and Antagonistic Salt Action:* Jacques Loeb, Rockefeller Institute for Medical Research, New York.

The author had shown that the ratio of the concentrations of antagonistic ions must remain within certain limits for the normal functioning of an organism. It is here shown that these limits remain approximately constant as the concentration of one of the ions is changed.

2. *The Polarized Fluorescence of Ammonium Uranyl Chloride:* E. L. Nichols and H. L. Howes, Physical Laboratory, Cornell University.

The remarkable fluorescence spectrum of this salt is described in considerable detail; observations being made at + 20° C. and — 185°.

3. *The Linguistic Classification of Pottawatomi:* Truman Michelson, Bureau of American Ethnology, Washington.

By study of the so-called "verbal pronouns," which afford most satisfactory classificatory criteria, it is shown that Pottawatomi belongs to the Ojibwa Group of Central Algonquian dialects.

4. *The Light Curve of XX Cygni as a Contribution to the Study of Cepheid Variation:* Harlow Shapley and Martha Betz Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The form of the maximum of brightness in XX cygni is variable from period to period and thus suggests the hypothesis that the periodic light and spectrum variations in this and other Cepheid variables should be ascribed to internal vibrations producing irregularities in luminosity instead of to double star phenomena.

5. *The Feebly Inhibited. III. Inheritance of Temperament; with Special Reference to Twins and Suicides:* C. B. Davenport, Station for Experimental Evolution, Carnegie Institution of Washington.

A statistical study of 89 family histories, affording 147 matings, leads to the conclusion that temperament is inherited as though there were in the germ plasm a factor E which induces the more or less periodic occurrence of an excited condition and its absence, e, which results in a calmness; also a factor C which makes for normal cheerfulness and its absence which permits a more or less periodic depression, the factors behaving as though in different chromosomes, so that they are inherited independently.

6. *Second Type Stars of Low Mean Density:* Harlow Shapley, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Because of its bearing on the question of the order of stellar evolution, the density of stars of the second spectral type is discussed from the standpoint of the dependability of the observation and theoretical work that is the basis of the derivation of occasional extremely low values.

7. *On the Pathological Action of Arsenicals upon the Adrenals:* Wade H. Brown and Louise Pearce, Rockefeller Institute for Medical Research, New York.

That arsenicals of diverse chemical constitution exert pronounced pathological action upon the adrenals has not been generally recognized. It appears from these observations that the adrenotropic action of arsenicals is one of the most constant and important features of arsenical intoxication, and it is suggested that therapeutic doses of some arsenicals may be found to produce definite stimulation of the adrenal glands.

8. *Variations in the Character and Distribution of the Renal Lesions produced by Compounds:* Louise Pearce and Wade H. Brown, Rockefeller Institute for Medical Research, New York.

Not all compounds of arsenic produce vascular lesions; some are capable of producing tubular nephritis; the difference in the pathogenic action being explainable only upon the basis of the chemical constitution of the different compounds of arsenic.

9. *Seven Points on a Twisted Cubic Curve:* H. S. White, Department of Mathematics, Vassar College.

If seven points on a twisted cubic be joined,

two and two, by twenty-one lines, then any seven planes that contain these twenty-one lines will osculate a second cubic curve.

Edwin Bidwell Wilson

SPECIAL ARTICLES

PRELIMINARY STUDIES ON INTRACELLULAR DIGESTION AND ASSIMILATION IN AMPHIBIAN EMBRYOS [1]

By means of a double stain of janus green and neutral red in an isotonic salt solution, the initial dilution of each stain being about 1:10,000, the yolk globules in the living cells of *Amblystoma* embryos may be differentiated into two types, which, for convenience of description, I designate as "alpha" and "beta" globules. The alpha globules stain selectively with janus green, at first greenish blue and then pinkish, presumably upon reduction of the dye. The beta globules stain selectively with the neutral red, and are by far the more numerous in the cell. When the same dyes are used singly in a dilution of 1:30,000 the alpha globules are relatively inert towards the red, and the beta globules are not stained by the green. In smears of living embryos which have been fixed upon the cover glass with the acetic-osmic bichromate mixture and stained with acid fuchsin according to the method of Bensley,[2] for mitochondria, the beta globules stain a deep, brilliant red while the alpha globules take on a duller tint, bordering on purple. The two types of globules may be similarly differentiated in sections prepared according to this method.

In smears of living cells which have been stained in janus green, alpha globules may be found here and there with deeply stained, blue excrescences upon their surface. These structures may be described as "alpha bodies." These are particularly distinct after the globule on which they occur has begun to take on the pinkish tint. They frequently appear as rows of slightly elongated masses connected by slender threads of the same kind of substance. In optical section some of them seem to dip into the substance of the globule while others project in varying degree above it. Some even have a very slight attachment to the globule. In other instances similarly staining substance is arranged in relatively coarse bands with ragged outline, a condition to which I shall refer again in considering the toxic action of the dye.

The different forms of alpha bodies I regard as indicative of different stages in their development. I have seen them in numerous cases arranged in rows over the surface of the globule as separate and distinct bodies. In this condition they have the form and color of mitochondria in the same preparation. In one instance, in fact, after I had begun to draw a globule with these separate and distinct alpha globules on its surface, I observed that some of the alpha bodies were changing their position relative to each other, and, giving continuous and close observation to those bodies, I saw some of them break loose from the globule and become indistinguishable in form and color from mitochondria which appeared elsewhere in the same preparation. Alpha bodies are visible also in smears and sections made according to Bensley's method for mitochondria as noted above.

Similarly there appear on some beta globules structures which may be called "beta bodies." These stain a deep red in contrast with the more delicately tinted body of the globule. In some respects they resemble in general structure the alpha bodies, but they are of a coarser nature. In some instances there is a hull of this substance around the greater part of the globule. Upon other globules it appears in ridges or as a chain of angular bodies. In smears of living cells I have seen beta bodies,

1 When this paper was written I was not acquainted with the contribution of C. Saint-Hilaire: "Ueber die Veränderungen der Dotterkörner der Amphibien bei der intracellulären Verdauung," *Zoologische Jahrbücher, Abt. f. Allg. Zool. u. Physiol.*, B. 34, Heft 2. After a careful study of his results I am convinced that Saint-Hilaire has not seen my "alpha bodies." Otherwise, my observations, in many respects, are in striking agreement with his. The differences in matters of interpretation can not be discussed here.

2 Bensley, R. R., "Studies on the Pancreas of the Guinea Pig," *American Journal of Anatomy*, Vol. 12, No. 3.

also, break loose from the globule. In the free condition they become indistinguishable from the free bodies which are abundant in the cells of amphibian embryos and which are ordinarily regarded as pigment. These pigment granules, although having a color of their own, at least upon their surface, stain deeply with neutral red. The beta bodies give the reaction for fat with Herxheimer's method.

That the beta bodies can not be degeneration products in the strict sense is evidenced by the fact that yolk globules remain intact for a long period in dishes of putrefying embryos, and that, in this condition, they do not stain selectively in neutral red and nothing like beta bodies can be found upon them. However, such globules, taken from disintegrating embryos, after they have been ingested by large protozoa, stain selectively in the food vacuoles of the living organism. In fact, large ciliates which have been feeding in dishes where embryos are disintegrating in a solution of neutral red, become gorged with deep red granules in dense masses. In one instance I have seen a swimming ciliate discharge a number of these granules, apparently as dejecta.

In the study of the reaction to janus green of yolk globules that have been ingested by protozoa I have met difficulties which have not been entirely overcome, but in one large ciliate I have succeeded in getting the reaction of two food vacuoles to the double stain of janus green and neutral red. In this case the surface of the globule stained a dense red and the other contents of the vacuole around the yolk globule a faint blue which changed in time to faint pink. The latter reaction was delicate but unmistakable.

A study of the artificial digestion, also, of yolk globules which have been taken from dead embryos supports the view that the selective staining of yolk globules and the bodies on their surface is due to processes of digestion. When such globules are digested in a mixture of pancreatin and neutral red many stain selectively and bodies appear on their surface which resemble beta bodies in living preparations. With prolonged digestion in pancreatin and neutral red the solution becomes yellow, and the core of the digesting globules yellow, while the bodies on their surface are deep red. Such reactions do not occur in digestion with pepsin in solution with neutral red, either with or without the addition of hydrochloric acid, although there is positive evidence of digestion in the mixture. Digestion with pepsin and janus green, however, brings about selective staining of globules which, during digestion, break up into very small bodies. These bodies stain a deep blue or blue-green. Such bodies occur, also, upon the surface of more faintly stained blue globules, in which case they resemble the alpha bodies of living preparations. Although they are usually larger than the typical alpha bodies, some of them are of about the same size.

In preparations of living cells stained with the double stain of neutral red and janus green I have on several occasions found an individual globule which had both alpha and beta bodies attached, the alpha bodies situated in bluish areas and the beta bodies in regions of fainter red. One such globule I had under observation for over eight and one half hours. During the latter part of this period beta bodies became detached from the globule while the globule became much reduced in size and retained the bluish tint over a relatively larger area than formerly. During this time an alpha body, also, disappeared from the surface of the globule, but it could not be recognized afterwards in the free condition as were the beta bodies. The latter, in the free condition, assumed the characteristics of the so-called pigment granules in the same preparation.

These preliminary observations have left a strong conviction in my mind that, in the digestion and assimilation of yolk in these embryos, enzymes effect a cleavage of the superficial substance of the globule; that, following this cleavage, the end-products of the process segregate into alpha bodies on the one hand and beta bodies on the other, and that the alpha bodies, probably undergoing some chemical change in the meantime, become free as mitochondria in the process of assimilation

into protoplasm, while the beta bodies are at this stage of development essentially a residue which later in cytomorphosis, possibly only after the circulatory system has assumed its nutritive rôle, may undergo further digestion.

This interpretation is further supported by the fact that janus green manifests much greater toxicity than does neutral red when embryos are grown in like dilutions of these dyes. This difference in toxic action becomes intelligible when one recognizes that it is the processes that are leading up to the construction of protoplasm that are obstructed by the reaction of janus green with the cell, whereas it is only the residue, so to speak, of these processes that is attacked by the neutral red. The latter dye has, however, a very considerable toxic action, the intracellular effects of which can be readily recognized. The yolk globules of embryos that have grown some time in a solution of neutral red have enormous, deeply stained red excrescences upon their surface. Many small structures like beta bodies in the fresh smears of living cells occur also under such conditions. The excessively large excrescences, which form large buds and separate into deeply staining, small globules, can not be regarded, of course, as perfectly normal. Neither are they degeneration products in the strict sense, for, as noted above, they do not occur on globules of degenerating tissues. They should be regarded, rather, as the result of normal processes that have been obstructed by the reaction of the products with the dye. That there is a more stable chemical compound established here is evidenced by the fact that these excrescences can be fixed with ammonium molybdate and preserved in microscopic sections, whereas neutral red stains of other structures in the cell can not be preserved by this method. Unusually large excrescences, also, which I have frequently seen on alpha globules, are probably the expression of the toxic action of janus green.

The experiments which have led me into this field began as a search for a method of detecting polarity in cells and physiological gradients within the embryo, my purpose being to correlate my work on the growth of the reflex arc in its relation to the development of behavior with recent researches upon gradients in lower organisms, particularly by Child.[3] In their bearing upon this original plan my results seem to justify the use of janus green and neutral red as indicators of digestion and assimilation of yolk in amphibian embryos. Beyond this, it seems to me, my observations give a clue, not only to the mechanism of intracellular digestion and assimilation of yolk, but also to the nature of the toxic action of the dyes that have been employed. My observations, however, are not presented here as conclusive evidence. They require critical review and extensive corroboration. But, awaiting the opportunity of another season, I feel justified in making this preliminary report, particularly in the hope of enlisting the interest of other biologists in the amphibian embryo as a unique source of information upon important phases of cellular biology. It would be interesting to know, for instance, the cytological side of the toxic action of the phenolic compounds which Gortner and Banta[4] used on amphibian embryos. With reference to mitochondria, my interpretation that they are derived in the amphibian embryo from yolk through the formation of structure which I call "alpha bodies" is wholly in accord with the conclusion of Cowdry[5] that mitochondria are associated with metabolism, and it is not at variance with the observations of M. R. and W. H. Lewis[6] that

[3] Child, C. M., "Studies on the Dynamic Morphogenesis and Inheritance in Experimental Reproduction, VIII., Dynamic Factors in Head-determination in *Planaria*," *The Journal of Experimental Zoology*, Vol. 17, No. 1.

[4] Gortner, R. A., and Banta, A. M., "Notes on the Toxicity of Dilute Solutions of Certain Phenolic Compounds, etc.," *Biochemical Bulletin*, Vol. 3, Nos. 11, 12.

[5] Cowdry, E. V., "The Comparative Distribution of Mitochondria in Spinal Ganglion Cells of Vertebrates," *The American Journal of Anatomy*, Vol. 17, No. 1.

[6] Lewis, M. R., and W. H., "Mitochondria (and Other Cytoplasmic Structures) in Tissue Cultures," *The American Journal of Anatomy*, Vol. 17, No. 3.

mitochondria in the cells of the chick embryo increase in size and divide by fission, when the cells are grown in vitro. If, as my observations indicate, mitochondria are involved in the anabolic phase of metabolism, one would expect them to grow in the cell of the chick embryo by accretion from end products of digestion absorbed by the cell; whereas in the amphibian embryo the food is stored within the cell as relatively stable substance and the whole transformation from food to protoplasm must take place in situ. So long as the cell is nourished from yolk which it contains, the mitochondria, I believe, grow upon the surface of the yolk globule. They may be certain end products of digestion, or they may be synthesized out of certain of the end products of digestion. However, before accepting this hypothesis it is important to know whether mitochondria occur in cells which have been deprived of their yolk by centrifuging. The work of Banta and Gortner,[7] and particularly that of Jenkinson,[8] upon the development of centrifuged amphibian eggs should be extended into the cytological field to determine wherein the mechanism is deficient in those cells which do not develop normally. Furthermore, the interpretations here offered, in so far as they relate to mitochondria, must be qualified by the consideration that their validity rests largely upon the nature of the bodies in the protoplasms which I have regarded as mitochondria. My judgment on this point is based upon the use of janus green as a vital stain and of Bensley's acetic-osmic-bichromate method, the two methods which, taken together, seem to be accepted as the nearest approximation to a specific test for mitochondria now at our command. But regardless of theoretical considerations, the observations which have been described are, I believe, substantially correct, and they are presented in this form with the hope of stimulating interest in a field of study which affords peculiar opportunity for making a definite advance in our knowledge of the mechanics of the cell, particularly in relation to the growth of the organism.

George E. Coghill
University of Kansas

[7] Banta, A. M., and Gortner, R. A., "Accessory Appendages and Other Abnormalities Produced in Amphibian Larvæ through the Action of Centrifugal Force," *The Journal of Experimental Zoology*, Vol. 18, No. 3.

[8] Jenkinson, J. W., "The Relation between the Structure and the Development of Centrifuged Eggs of the Frog," *Quarterly Journal of Microscopical Science*, April, 1914.

TRAINS OF BEATING LIGHT WAVES

If two spectra, having the same longitudinal axis but reversed in color (*i. e.*, respectively red-violet and violet-red), are brought to interfere, the interference should occur only along the single transverse line of coincidence and therefore be inappreciable. If it is visible, then light waves of slightly *different* wavelengths, lying symmetrically on either side of the common transverse axis, must also be capable of interference in optics, in complete analogy with the case of musical beats in acoustics. After long searching I found that the occurrence of the phenomenon in question can be shown experimentally. Its scintillating appearance is exceedingly striking. It is complete within a transverse strip of the spectrum but one half to one third the width of the sodium lines. It partakes of the general characters of elliptic interferences however, except that the ellipses are now extremely eccentric (needle-shaped in other words) and confined to a single color. If the given width be regarded as the distance between two fringes and estimated as $d\lambda = 2.4 \times 10^{-8}$ cm., if x be the distance along the axis of propagation within which one reenforcement occurs, then

$$x = \lambda^2/d\lambda = 36 \times 10^{-10}/2.4 \times 10^{-8} = .15 \text{ cm.},$$

or the limiting group wave-length of the light waves is over a millimeter. Details and allied results, for which there is no room here, will be found in the complete paper, now in the hands of *The American Journal of Science*.

Carl Barus
Brown University,
Providence, R. I.

SOCIETY OF AMERICAN BACTERIOLOGISTS

VI

Sanitary Bacteriology

Under the supervision of W. W. Ford

Bacteria in City, Country and Indoor Air: WILLIAM W. BROWNE.

The New York State Commission on Ventilation under the direction of Professor C.-E. A. Winslow undertook a systematic examination of the air in and about New York City. During the survey 353 samples of air were examined and may be roughly divided as follows:

1. City air .... 134 samples.
2. Country air .... 85 samples.
3. Office air .... 87 samples.
4. Factory air .... 47 samples.

The samples were collected and examined according to the methods proposed by the Committee on Standard Methods for the Examination of Air of the American Public Health Association. In each examination 5 cu. ft. of air were pumped through a sand filter by (1) hand pump in the field, (2) power pump in factories and offices. Samples were plated on gelatin and litmus lactose agar and plated at 20° C. and 37° C., respectively.

Summary of Results

Source	No.	Microorganisms per Cu. Ft.				Strep. per 100 Cu. Ft. of Air
		20° C.	Per Cent. Below 125 per Cu. Ft.	37° C.	Per Cent. Below 125 per Cu. Ft.	
Country	85	56	(94%)	30	(94%)	12
City............	134	72	(82%)	32	(98%)	11
Offices.........	87	94	(80%)	80	(90%)	22
Factories.....	47	113	(82%)	63	(92%)	43
Schools[1]......	684	96	(78%)	—	....	30

Conclusions

1. Microorganisms developing at 20° C. on gelatine are generally under 50 per cu. ft., rarely over 100 per cu. ft.

2. Microorganisms developing at 37° C. are rarely over 50 per cu. ft.

3. Number of *Streptococci* equals 10 per 100 cu. ft.

4. Air of occupied spaces contains more bacteria than open spaces and shows greater fluctuations.

[1] From Baskerville and Winslow school-room air examination in New York City, in which same methods were employed.

The Efficiency of Endo's Medium in Detecting Members of the Colon Group: G. C. SUPPLEE.

Fifty-three cultures were studied and identified. Twenty-nine of these were found to belong to the colon group. Eleven were closely allied forms, but could not be included within the group if strict adherence to the classification was observed. Three were coccus forms; four were of the acid peptonizing type and two failed to ferment any of the sugars and produced no change in milk. The data were not complete from four of the cultures.

Representatives of the colon types and the acid peptonizing type were plated upon Endo's medium after different degrees of attenuation. The results of these experiments showed that the intensity of the reaction was weakened as the attenuation increased. The color reaction of the *aerogenes* and *acidi lacti* types tended to fade to a white or pink. The fading took place much sooner if the colony developed on the surface or if the culture was at its greatest vigor.

Since sub-surface development gave rise to many doubtful reacting colonies, two hundred and thirteen such colonies were studied and fifty-seven per cent. were found not to belong to the colon group.

From experiments with pure and mixed cultures of the colon varieties it was found that about a plus four tenths acidity gave the maximum number of reactions.

Organisms which Do Not Belong to the Colon Group and Produce Black Fields on Æsculin-Bilesalt Media: J. VANDERLECK.

In the summer of 1913 more than 3,000 æsculin-agar plates made of milk were examined and 700 colonies selected for further study. As a result 10 organisms were found to produce black colonies on æsculin-bilesalt media at blood heat inside 48 hours and which did not have the least relation to the colon group. These organisms showed hardly any action in milk, gas production in sugars was absent in the majority and sometimes liquefaction combined with alkalinity was present. These organisms came from one milk district—Huntingdon—and could not be recovered from that source in the following spring. However, another exception appeared for a short time in large numbers. This organism was in many respects closely related to the colon group, produced first acid in milk followed by alkaline digestion and formed gas in saccharose. Altogether 135 organisms were tested in the examination.

Working at lower temperature and keeping the plates for at least 5 days, more exceptions would appear, 7 of which were carefully studied. Col-

onies appearing in water samples were also tested, but among 250 test cultures no exceptions were encountered. Our conclusions of these exhaustive tests are that the æsculin-bilesalt test is thoroughly reliable. Out of 1,200 samples analyzed only in one case a wrong impression was obtained on account of the presence of some exceptional organism. A full description of this investigation will appear in the *Centralblatt für Bakteriologie*.

Numbers and Efficiency of B. bulgaricus Organisms in Commercial Preparations Examined During the Period January–June, 1914: Ruth C. Greathouse.

The number and efficiency in acid production of *B. bulgaricus* in commercial preparations are an index of the value of the preparations.

Forty commercial preparations, the products of twenty-three firms, were examined between January 15, 1914, and June 1, 1914. These samples were collected fresh from the manufacturers and held under conditions of temperature and humidity which are practicable for commercial handling. They contained, in the case of dry cultures, from none to 250,000 living *B. bulgaricus* per gram; in the case of liquid cultures, from 2,300 to 320,000,000 per c.c.; in the case of sour milk drinks, from 800 to 790,000,000.

The maximum acidity produced in milk by the *B. bulgaricus* in these preparations varied from 1.20 per cent. to 3.41 per cent. acid calculated as lactic. The ability of the *B. bulgaricus* to produce acid was decreased in the old preparations. The amount of decreases averaged 38.5 per cent. in the case of dry cultures kept on ice for two months, and 26.4 per cent. in the case of liquid preparations kept on ice for two weeks.

The strains producing different degrees of acidity were examined for differences in morphology, staining properties and curd production in milk, which would indicate that they were separate organisms, but no such differences were found.

Agglutination Studies of Milk from Cows Affected with Contagious Abortion: L. H. Cooledge.

Milk studied was obtained from a herd in which a high percentage of animals have repeatedly given positive complement fixation and agglutination tests for contagious abortion and having a record of frequent abortions.

The milk from each quarter of 61 cows has been examined at intervals during the last 6 months. Of these the milk of 18 (30 per cent.) has given a positive agglutination test with *Bact. abortus*, in one or more quarters, at some time, or during this period. The power of the milk of one quarter to agglutinate the abortion bacterium has been observed to spread to another quarter and finally to all four; it has also been observed to gradually die out. Milk drawn at about the middle of the milking has the strongest agglutinating reaction.

An attempt to demonstrate the presence of *Bact. abortus* in milk that agglutinates the organism has resulted as follows. Out of 18 quarters the milk of which agglutinate the abortion bacterium the milk of 14 produce lesions in guinea-pigs which are like the typical lesions caused by a pure culture of *Bact. abortus*.

In the 7 cows whose milk has gradually acquired the power of agglutinating the abortion bacterium during this experiment one or both of the rear quarters have been the first to show agglutination. This suggests contamination of the rear quarters by genital discharges.

The Presence of Bacillus abortus in Milk: Alice C. Evans.

Special methods of plating milk samples which were drawn aseptically have shown that the bacillus of contagious abortion occurs commonly in certified milk in the vicinity of Washington, D. C., and Chicago, Ill. These organisms grow profusely on serum agar plates. About 30 per cent. of the samples of milk from two certified dairies near Chicago, which were plated on serum agar, showed this organism to be present in milk at the time of drawing from the udder, in numbers varying from 110 to 4,300 per cubic centimeter. In one sample taken from a herd which does not produce certified milk, 50,000 of the *Bacillus abortus* were found per cubic centimeter. This organism grows abundantly in the cream layer, with the formation of acid, but it grows sparingly in milk from which the cream has been removed. Four per cent. of lactic acid in the milk does not check the multiplication of *Bacillus abortus* in the cream layer.

The Influence of Milk and Carbohydrate Feeding on the Bacteriology of the Intestine: Leo F. Rettger and Thomas G. Hull.

The intestinal flora of white rats and of fowls is determined in a very large measure by the diet. White rats that were fed ordinary white bread and green vegetable food exhibited an intestinal flora which closely resembles that of man. Soon after the diet was changed to mixed grain a marked transformation took place. When to the diet of bread and vegetables a liberal amount of milk or of lactose was added the ordinary mixed flora quickly became simplified, and often presented the picture of only two or three types of bacteria, namely *B. bifidus* of Tissier and *B. acido-*

philus of Moro. During continued milk or lactose feeding the *acidophilus* type may give way eventually to *B. bifidus.* Similar results were obtained in the domestic fowl, the *acidophilus bacillus* being the most prominent. The feeding of other carbohydrates, dextrose, maltose, levulose, dextrin and starch did not bring about such a change.

The feeding of bacteria, even in large numbers, will in itself exert very little if any influence on the intestinal flora. *B. bulgaricus* suspensions obtained from plain agar growths could be recovered only occasionally from the feces, and then in very small numbers only. On the other hand, when sterile milk, whether sweet or sour, was fed to white rats which exhibited the usual mixed flora in which organisms of the *acidophilus* type were very few or absent, *B. acidophilus,* which in many respects is practically indistinguishable from *B. bulgaricus,* rapidly made its appearance in the intestine and for a time occurred there in relatively large numbers.

A Simple Test for B. sporogenes in Milk and Water: JOHN WEINZIRL.

The sample of milk to be tested is placed in a sterile test tube, and enough solid paraffin is added to make when melted, a layer one eighth of an inch in thickness. The tubes are then placed in the Arnold and heated at 80° C. for ten minutes. After heating, they are cooled rapidly; this causes the melted paraffin to solidify and form a cover which effectively excludes atmospheric oxygen. The cultures are then incubated at 37° C. for 24 hours. If *B. sporogenes* is present, it digests the lactose and forms gas which lifts the paraffin plug.

The test is simple, cheap and easy of application. When applied to market milk it gave the following results:

90 samples of 5 c.c. milk each gave 28 per cent. positive.

112 samples of 10 c.c. milk each gave 37.5 per cent. positive.

34 samples of 15 c.c. milk each gave 50 per cent. positive.

Utensils as a Source of Bacterial Contamination of Milk: M. J. PRUCHA, H. A. HARDING, H. M. WEETER.

This investigation attempted to measure the amount of bacterial contamination received by the milk from the utensils in which it was handled between the cow and the milk bottle.

The utensils were carefully washed in the ordinary way, being scrubbed with brush in a warm solution of Wyandotte and then rinsed out with warm water.

In the accompanying table is given the summary of the experiments.

All Utensils Sterile

	Bacteria per C.c.
1. Milk leaving the barn	2,558
2. Bottled milk	3,875
Utensils Washed—Only Bottles Sterile	
3. Increase due to pails	57,077
4. Increase up to clarifier	15,353
5. Increase due to clarifier	172,763
6. Increase due to cooler	19,841
7. Increase due to bottler	247,611
8. Total in bottled milk	515,203

An Improvement in the Composition of Lactose Bile: THOMAS W. MELIA.

Lactose bile, as employed at present, has certain disadvantages.

First: The bile is not always fresh.

Second: The media, after sterilization, contains a heavy sediment in the fermentation tubes which interferes with the development of the test.

Third: Many authors have criticized the inhibiting power of the bile salts upon *B. coli.*

In regard to the first disadvantage it was found best to purchase ox gall from freshly slaughtered animals and have it delivered within a few hours to the laboratory. It is then evaporated to dryness in a vacuum dryer and stored away in one pound airtight containers. The bile will keep indefinitely.

The sediment present in fresh bile and in the sterilized media was found to contain mucin, lime salts and broken gall stones (cholesterine) probably formed by the streptococcus growth. The bile should be settled and only the clear supernatant liquid used.

The sediment in the fermentation tubes may be prevented by making a five per cent. instead of a ten per cent. solution of bile media.

The known inhibiting power of bile salts led to an investigation of the best strength of bile media to employ.

Table showing relative efficiency of the five and ten per cent. bile media on ordinary quality of drinking waters (60 in number)

	Five Per Cent. Dried Ox Gall			Ten Per Cent. Dried Ox Gall		
	C.c. 0.1	C.c. 1.0	C.c. 10	C.c. 0.1	C.c. 1.0	C.c. 10
24 hour results	2%	22%	50%	2%	16%	31%
48 hour results	13%	31%	75%	7%	18%	40%
72 hour results	15%	49%	82%	9%	27%	51%

Attenuated *B. coli* is more readily shown, also less interference from overgrowths in the five-per-cent. bile media.

Infection and Immunity

Under the supervision of J. A. Kolmer

The Parasite of Oral Endamœbiasis. Endamœba gingivalis (Gros): Allen J. Smith, M.D., and M. T. Barrett, D.D.S.

The authors present a detailed comparison of the amœbiform organisms which have been announced as discovered in the human mouth and related parts, including the amœbæ of Gros (1849), of Steinberg (1862), of Grassi (1879), of Flexner (1892), Kartulis (1893), of Prowazek (1904) and of Verdun and Bruyant (1907). They conclude that of these all save the last are really specifically identical and therefore propose as the proper nomenclature for this organism *Endamœba gingivalis* (Gros) with synonyms: *Amiba buccalis* Steinberg, 1862; *Amœba dentalis* Grassi, 1879; *Entamœba kartulisi* Döflein (*Amœba maxilaris* Kartulis, 1907); and *Entamœba buccalis* Prowazek, 1904. The organism is an amœba which ordinarily is of 30 or 35 micromillimeters in diameter in the resting stage, has a fairly differentiated ectosarcous periphery, a granular endosarc, full of nutrition vacuoles in which are found bacteria, remnants of leucocytic nuclei and red blood cells or their detritus. There is no contractile vacuole. The nucleus is small, usually central or subcentral, but occasionally excentric; is seen with difficulty if at all in the unstained specimen; is poor in chromatin and vesicular in appearance, with small central "binnenkörper" and a delicate but irregularly thickened chromatic membrane. The pseudopodia are ordinarily single or few, broadly lobose to long and digitate; cellular and pseudopodial motility active but variable; reproduction surely by binary division and by gemmation; persisting cysts formed, but no reproduction cysts as yet observed. Habitat in the pus of pyorrhea pockets, on the neighboring mucous and dental surfaces, in the tonsils, in the abscesses of the jaw, etc.

The writers urge their inability to distinguish morphologically between *Endamœba gingivalis* (Gros) and *Endamœba histolytica* Schaudinn. While stating this view of morphological indistinguishability, the writers are unwilling to declare general biological identity, although they suspect it; and acknowledge that such identity, if established, would open the door to need for important revision of our present ideas in regard to amœbic dysentery.

The Production and Detection of Specific Ferments for the Typhoid-coli Group: George H. Smith.

The results of the application of the Abderhalden reaction to the investigation of three important problems were presented, namely:

1. To what degree does the property of specificity extend among ferments produced in the body through resistance to infective agents?

2. Which method of administration—intravenous, intraperitoneal, or subcutaneous—is the most effective for immunization?

3. Is there any difference in rapidity of action between living bacteria, killed bacteria and killed sensitized bacteria when used for immunization?

As regards specificity of ferments, reference is made to previous work with *Staphylococus, Streptococcus, Pneumococcus, Micrococcus catarrhalis* and *B. influenzæ* in which a complete specificity of ferments was demonstrated. In the present instance rabbits were immunized against *B. coli communis, B. coli communior*, paratyphoid bacillus A, paratyphoid bacillus B, and two strains of typhoid bacillus known as the Hopkins and Rawlings strains. The results of these experiments would indicate that ferments produced as a result of injections with the bacteria employed are highly specific.

The experiments with the different methods of injection, and with living, killed unsensitized and killed sensitized bacteria were conducted as follows:

The typhoid bacillus (Rawlings strain) was the organism employed. Doses of 50 million were given intravenously, intraperitoneally, and subcutaneously. The animals were bled at stated intervals and the serums tested by the Abderhalden method for specific ferments.

From this work it appears that the intravenous method of administration is most rapid in its results, and the subcutaneous gives the slowest response, and that the killed sensitized bacteria are most potent in inducing a rapid formation of ferment.

In verification of this latter conclusion, subcutaneous injections were given, simultaneously, of killed typhoid and killed paratyphoid B, of killed typhoid and killed sensitized paratyphoid B, of sensitized typhoid and killed paratyphoid B, and killed sensitized paratyphoid B. When killed un-

sensitized organisms of both types were injected, ferments for paratyphoid B appeared in 33 hours, and for typhoid in 36 hours. When killed unsensitized typhoid and killed sensitized paratyphoid B were employed specific ferments for paratyphoid B appeared after 16 hours, and for typhoid after 35 hours. When killed sensitized typhoid and killed unsensitized paratyphoid B were injected ferments for typhoid were demonstrable after 17 hours, and for paratyphoid B after 36 hours. With the final combination in which both types were sensitized the serums showed specific ferments for both kinds of bacteria after 18 hours.

The above experiments indicate that previous treatment of the bacteria with immune serum renders them more susceptible to assimilation by the body and thus enables them to bring about a more rapid formation of the specific ferments which may be detected by the Abderhalden test.

Recent Studies on Pellagra: J. F. SILER, P. E. GARRISON AND W. J. MACNEAL.

The theory that pellagra is due to the ingestion of maize or maize products, either good or spoiled, is wholly inadequate to explain the distribution of the disease actually observed in Spartanburg County, S. C.

The conception that pellagra is a specific infectious disease in some way transmissible from person to person is strongly supported by our observations. The higher incidence of pellagra in the more populous districts and its occurrence in definite foci are in accord with this view. Definite tendency to self-limitation of the attack of pellagra without specific treatment and without change in diet is very evident in many cases, and especially so in children.

The manner of origin of pellagra in its endemic foci from year to year indicates that the disease spreads from old cases as centers and that it is, as a rule, transmitted through relatively short distances, within the same house or to the house next door. The disease spreads most rapidly in communities without efficient provisions for sewage disposal and spreads hardly at all in communities with sanitary sewer systems.

We have been unable to produce a recognizable attack of pellagra in any experimental animal, nor have we as yet recognized the specific infectious agent of the disease.

The Schick Toxin Reaction for Immunity in Diphtheria: JOHN A. KOLMER AND EMILY L. MOSHAGE.

Schick has proposed a simple clinical test for immunity to diphtheria consisting in the intracutaneous injection of 1/50th the minimal lethal dose of toxin for a guinea-pig. If there is less than 1/30th of a unit of antitoxin in each cubic centimeter of the patient's serum, the injected toxin acts as an irritant and produces an inflammatory reaction. If 1/30th of a unit or more antitoxin is present the toxin is neutralized, no reaction follows and the individual is regarded as being immune to diphtheria.

The test has been advocated as a means of testing the response of active immunization with toxin-antitoxin mixtures and to detect susceptibility to diphtheria.

The objects of this study were as follows:

1. To apply the toxin skin test to a large number of apparently normal persons to determine susceptibility to diphtheria at different ages.

2. To determine quantitatively the antitoxin content of the blood serum of persons reacting positively, slightly positively, doubtfully and negatively in order to further study the toxin test under conditions where the quantity of antitoxin in the blood is known.

3. To study the degree and duration of immunity to diphtheria in normal persons following an injection of diphtheria antitoxin.

4. To study the degree and duration of immunity among persons suffering with scarlet fever and receiving an injection of diphtheria antitoxin.

5. To study immunity during and following an attack of diphtheria.

6. To study the practical value of the toxin skin test in determining which persons should be immunized with antitoxin when exposed to diphtheria.

I. In all 1,265 inoculations were made. Of these 447 were among persons most of whom were healthy and well; a few were suffering with various chronic diseases and were tested while in various hospitals in Philadelphia.

The reaction has demonstrated that children between the ages of one and eight years are most susceptible to diphtheria.

II. The serums of a number of persons were tested for antitoxin content with the following results:

(*a*) The serums of persons reacting negatively to the toxin test usually contained at least 1/20th of a unit of antitoxin per cubic centimeter of serum.

(*b*) The serums of persons reacting weakly positive to the toxin test usually contain from 1/40th to 1/160th of a unit of antitoxin per cubic centimeter of serum.

(c) The serums of persons reacting strongly positive were found to contain less than 1/30th of a unit per cubic centimeter of serum and frequently none at all could be detected.

These results corroborate those of Schick, Park and Zingher.

III. The duration of passive immunity to diphtheria was studied in 106 persons by applying the toxin skin test at varying intervals after the administration of 1,250 units of antitoxin subcutaneously.

The immunity conferred was apparently efficient for ten days; after this interval antitoxin rapidly disappeared, so that after four to six weeks the immunity may be regarded as having entirely disappeared.

IV. The toxin skin test was applied to 362 persons in the various stages of scarlet fever and at varying intervals of time following the subcutaneous injection of 2,500 units of antitoxin to study the duration of passive immunity in scarlet fever.

It was found that in scarlet fever passive immunity following an injection of diphtheria antitoxin is of shorter duration than that induced among normal children in that 10 per cent. of the former are susceptible within ten days after receiving antitoxin.

V. The toxin test was also applied to 350 persons, mostly children, suffering with diphtheria and receiving from 10,000 to 100,000 units of antitoxin by subcutaneous injection. The high percentage of positive reactions during the first ten days of the disease and after large doses of antitoxin was quite surprising. As a general rule these occurred among children with severe infections. It was also found that patients were in general just as susceptible after an attack of diphtheria as before; in other words, it would appear that the body cells produce little or no homologous antitoxin and the immune antitoxin is soon eliminated.

VI. Practical experience with a small epidemic of diphtheria has increased our confidence in the toxin test as a means of detecting persons susceptible to diphtheria. The chief practical value and application of this test is the detection of non-immune individuals and immunizing those only instead of all persons indiscriminately. The reaction has a special field of usefulness in hospitals and wards for the care of children.

While cultures were made of a large number of the persons tested, there was found no constant relation between the occurrence of diphtheria bacilli in the upper air passages and the toxin test.

The Mechanism of Abderhalden Reaction: J. BRONFENBRENNER.

When the placenta and serum of a pregnant individual are placed on ice, instead of the thermostat, the Ninhydrin reaction substances do not appear in dialysate. The analysis of the ingredients, however, shows that both the serum and placenta underwent changes—namely, placenta was sensitized by fixing upon itself the specific substances from the serum, and the serum was exhausted of its specific substances. Such a serum, moreover, when separated from placenta and transferred to 37° shows gradual deterioration of its complement, and parallel with it, the increase of dialyzable Ninhydrin reacting substances as the incubation at 37° goes on. Similar tendency to apparent autodigestion can be produced also in any normal serum by placing it for a certain time in contact with sensitized placenta (but not with normal placenta). The absorption by the placenta of specific constituents of pregnant serum is not due to a mechanical absorption, but is strictly specific, at least within certain quantitative limits.

The action of this specific union between the substratum and specific constituents of the serum upon the residue of the serum is such that the normal antitrypsin of the serum is inactivated (or absorbed) and the normal proteolytic ferment is set free. The action of this non-specific ferment upon the residue of the serum is responsible for the appearance of dialyzable substances. This action of the ferment upon the serum can be arrested in the Abderhalden test by the addition of any substance acting as antitrypsin, as, for instance, the serum albumen or serum lipoids, both in the pure form and in the form of excess of whole normal serum. The products of such autodigestion of the serum are toxic to homologous animals, and their appearance can be made evident by the biological tests (anaphylaxis).[1]

Do Bacteria Produce Pyrogenic Poisons? D. H. BERGEY, M.D.

It is believed that the pyrogenic substances act by (a) the stimulation of the heat-producing centers, or, (b) the inhibition of heat dissipation through conduction, radiation and evaporation, or (c) by the combination of these two processes.

It is well known that the injection of animals with distilled water, or with sterile bouillon leads to fever production. Hence it was thought probable that it might be possible to show the presence of fever-producing poisons in a filtered bouillon

[1] The protocols will appear in one of the following numbers of the *J. of Exper. Med.*

culture of *Bacillus typhosus*, if the filtrate produced a uniformly higher degree of febrile reaction than did the sterile bouillon, before bacteria had been grown in it.

It was also thought possible that the presence of fever-producing substances in the culture filtrate could be demonstrated by treating animals for some time with these filtrates and then using the serum of these animals to inhibit the fever production in normal animals by injecting serum and filtrate at the same time.

It was soon determined that the serum even of normal animals of the same species injected into healthy animals in itself caused a febrile reaction.

It was not possible to demonstrate definitely that typhoid bacillus produces soluble toxin which is responsible for the febrile reaction in typhoid fever.

It seems more probable that the febrile reaction is due to substances liberated from the tissue cells under the influence of the organisms.

How Bacterial Vaccines Act: E. C. L. MILLER, M.D.

The protein of the dead germ bodies contained in ordinary bacterial vaccines probably produces specific immunity. The degree of this immunity is probably slight and the question is raised whether the immunity measures the entire therapeutic value of the vaccine. The fact that well-washed bacteria have much less tendency to cause a reaction is taken as evidence that besides the dead germs there are reaction-producing or pyrogenetic substances in the vaccines. The fact that bacterial vaccines must usually be administered in doses that produce some reaction is taken as indicating that the pyrogenetic substances have some part in the improvement. One way in which they may aid is in making the immunity effective and this may be either by focal or general reactions. It is suggested that the existence of these two constituents in bacterial vaccines should be more generally recognized so that they may be used separately or together, as may be indicated.

A Contribution to the Pathogenesis of the Avian Tubercle Bacterium: L. R. HIMMELBERGER AND L. A. MOSHER.

The communication deals with the pathogenic effects of living cultures of avian tubercle bacteria on rabbits. The problem was undertaken to study the type of tuberculosis, whether generalized or localized, produced by intravenous injection of living bacteria of the avian type.

The work presented in the communication involves the results obtained by intravenous injection of thirty animals. With but one exception all developed a generalized tuberculosis, usually terminating fatally in from twenty to one hundred days. In classifying the type of disease produced, the nature and distribution of the lesions and the course of the disease in the animal were the criteria used.

In view of the results obtained the authors desire to suggest that the use of avian cultures in cattle immunization is unsafe both from an economic and public-health point of view. From the economic standpoint great danger of infecting by vaccination exists since the senior author[2] has previously shown that calves can be infected by tubercular material from avian sources. From the public health point of view it is reasonable to suppose that the avian type of organism would prove equally as pathogenic for humans as the bovine type.

Reciprocal Relations of Virulent and Avirulent Cultures in Active Immunization: PHILIP B. HADLEY.

This paper presented data to show that among seventeen non-virulent strains of the fowl cholera organism only one (Culture 52) possessed an immunizing value, but that the immunizing value of this one was perfect, in so far as inoculation with rabbits with 0.000,000,01 c.c. produced permanent active immunity against the most virulent strain obtainable. When tested against other virulent strains, Culture 52 protected in many cases, but the point was especially emphasized that in all cases in which Culture 52 alone failed to protect, perfect immunity was developed through inoculation with Culture 52, followed, after an appropriate time, by inoculation with Culture 48. By the use of one or the other method, rabbits may now for the first time be permanently protected against any virulent strain of the fowl cholera bacterium yet obtained.

These experimental results were used as the basis for more general observations.

1. On the possibility of more efficient active immunization in many communicable diseases by discovery of what may be termed "Immunizing strains."

2. On the varied physiological characteristics which may be possessed by microorganisms manifesting identical morphological, cultural and biochemical features.

3. On the heretofore unconfirmed experiments of Pasteur regarding the possibility of immunization against fowl cholera by means of non-virulent cultural material.

[2] *Cent. f. Bakt. Erst. Ab.*, Bd. 73.

Symposium with Section K, A. A. A. S.
Ventilation

Under the supervision of C.-E. A. Winslow

Ventilation in Its Relation to Air-borne Diseases: DR. A. C. ABBOTT.

In several hospitals for the care of contagious diseases in England, France, and in one in particular in this country, it has been conclusively demonstrated that certain of the so-called "air-borne" diseases of different natures may be treated side by side in the same ward without fear of greater transmission than commonly occurs when they are treated in separate wards. Obviously such observations justify grave doubts of the aerial conveyance of disease.

Though we do not know the causative agents of the majority of the so-called "air-borne" diseases, yet presumably they are particulate and never gaseous in nature. Therefore, they behave in the air, when they get there, just as do other suspended particles.

From information obtained through the study of another phase of the subject we know that a number of diseases may be conveyed through the air, but here it is always through the agency of insects acting as vectors or as hosts for the infective parasites. This, obviously, has more to do with wire screens than with ventilation.

In the light of the foregoing, I do not believe that ventilation has anything whatever to do with either the transmission of the so-called "air-borne" diseases, or the lessening of their transmission, and I am further of the opinion that transmission by way of the air, strictly speaking, is of infinitely less importance than transmission by animate and inanimate carriers that have been in intimate contact with the patient.

Some Fundamental Physical Factors in the Problem of the Control of Atmospheric Environment: E. B. PHELPS.

The physical problem of heat dissipation from the body is conditioned externally by four prime factors; temperature, humidity, velocity of air movement and radiation. Experimental determination of the mutual relationship and individual influence of the first three of these is reported.

A simple air conditioning apparatus furnished the experimental air at temperatures of 6° to 40° C., relative humidities 30 per cent. to 90 per cent. saturation and velocities up to 250 cm. per second. The heat loss was determined from a continuously moist skin surface exposed to these various air conditions. The surface formed the only exposed portion of a calorimeter in which accurate thermo-control was provided, the actual heat lost being compensated electrically and determined by noting the volume of gas produced electrolytically by the passage of the same heating current through dilute sulphuric acid. The results between 20° and 40° are expressed by the f llowing equation:

$$c, \sqrt[4]{v}[.0072(46.7 - p) + .00294(37 - t)].$$

c, is the heat loss in calories per minute per sq. centimeter.

v, the velocity of movement in centimeters per second.

p, the absolute humidity in milligrams per liter, and

t, the temperature Centigrade.

Below 20° a complicating humidity relation was developed and at lower temperatures this relation reversed the one found above, so that increasing humidity brought about increasing heat loss. This latter relation has not yet been formulated.

Standards of Ventilation in the Light of Recent Research: C.-E. A. WINSLOW.

The investigations of the New York State Commission on Ventilation have indicated that even quite extreme conditions of heat and humidity (86° with 80 per cent. relative humidity) have no measurable effect upon the rate of respiration; dead space in the lungs; acidosis of the blood; respiratory quotient; rate of digestion and rate of heat production (both measured by oxygen consumption); protein metabolism (measured by determination of creatinine in the urine) or skin sensitivity.

On the other hand, the working of the circulatory and heat-regulating machinery of the body was markedly influenced by even a slight increase in room temperature, as, for example, from 68° to 75° with 50 per cent. relative humidity in both cases. In a hot room (86°—80 per cent. relative humidity) the rectal body temperature usually rose during the period of observation; in a warm room (75°—50 per cent. relative humidity) it remained on the whole about constant; in a cool room (68°—50 per cent. relative humidity) it fell. The average body temperatures attained under these three-room conditions were 37.41°, 36.99° and 37.73°, respectively. The increase of heart rate on passing from a reclining to a standing position became greater by an average of 7 beats during a sojourn in the hot room, while it became less by an average of 3 beats in the warm room and by an average of 7 beats in the cool room.

Elaborate psychological tests failed entirely to

show any effect of even the severe 86°—80 per cent. relative humidity conditions upon the power to do mental work under the pressure of a maximum efficiency test.

The results with physical work (lifting dumb bells and riding a stationary bicycle) were much more definite. Again maximum effort tests showed no appreciable influence of room temperature but when the subjects had a choice they accomplished 15 per cent. less work at 75° and 37 per cent. less at 86° than at 68°.

As to the effect of stagnant air contaminated by a group of subjects so as to contain an average of from 20 to 60 parts of carbon dioxide per 10,000 the observations of the commission are entirely negative so far as the physiological and psychological and efficiency tests above mentioned are concerned. In certain experiments the appetite of the subjects as measured by the amount of food consumed when a standard luncheon is served to them seemed to be reduced in the stagnant air.

Recent research has, on the whole, strengthened rather than weakened the arguments for ventilation. It has shown, however, that the physical quality of the air as well as the amount should be considered. Temperature standards must come into more general use, and a rise above 70° must be recognized as a sign that discomfort is being produced and efficiency decreased and vitality lowered.

Symposium with Sections C and K, A. A. A. S. The Lower Organisms in Relation to Man's Welfare

Under the supervision of John Johnson.

Theories of Fermentation: C. L. ALSBERG.

There are two types of theories of fermentation. One deals with the mechanism by which the substance fermented is converted into the end products of fermentation. The other deals with the physiological rôle which fermentation plays in the life of the fermentation organism. The latter only was considered in the paper.

The great question which has always confronted the investigator in judging the physiological significance of fermentation is the difficulty of explaining why enormous quantities of material are attacked by a relatively small mass of fermentation organisms. Until recently most investigators have looked at this question only from the point of view of matter, and not from the point of view of energy.

In the present paper it is suggested that fermentation is nothing other than the expression of the metabolism of energy of a microorganism. In the case of microorganisms in which the surface as compared with the mass is very great, the energy requirements must of necessity be enormous. Moreover, microorganisms live in a liquid medium which is an excellent conductor of heat. Therefore, the radiation losses of microorganisms must be excessive. Taking these factors into consideration it is easy to understand why a small mass of organisms converts a relatively large mass of material in its effort to satisfy the energy requirements of its protoplasm.

The Bacteria of the Intestinal Tract of Man: A. I. KENDALL.

It has been stated that the average healthy adult on a normal mixed diet excretes daily in the feces a number of bacteria, which have been variously estimated from 128 billion to 33 trillion. It is very certain that this number of bacteria is not taken in the food, and, furthermore, the fecal organisms are not necessarily the same as those found in the food. Hence the conclusion is reached that there must be a very great daily proliferation of bacteria in the intestinal tract.

The question naturally presents itself, why is there such a tremendous growth of bacteria daily, and why is it that the bacteria taken in with the food are not those which appear in the fecal contents? A rapid survey of the life history of the intestinal bacteria will explain at least some of the facts. At birth the intestinal content, the meconium, is sterile. Very shortly after birth bacteria make their appearance in the mouth of the new born, and organisms appear in the meconium from four to twenty hours post partum, depending upon environmental conditions. This is a period of mixed infection, and the number of organisms in the meconium increases rapidly after the first food enters the intestinal tract. After two to three days post partum, when the intestinal tract has become thoroughly permeated with milk, the organisms observed in the feces—for the meconium has largely disappeared by this time—begin to assume a monotony of form and a regularity of type, which contrasts sharply with the preceding period of mixed infection.

The types of bacteria which constitute the normal fecal flora of the nursling are few in number and definite in their chemical characters. The most prominent of these, *B. bifidus*, so-called because of its developmental peculiarities in artificial media, is a strict anaerobe.

B. bifidus is an organism which does not thrive in artificial media in the absence of sugars, and it

is not surprising to find, therefore, that as the breast-fed infant becomes older and its dietary demands more varied, *B. bifidus* tends to disappear from the fecal mass. In the case of bottle-fed babies, this disappearance practically coincides with the substitution of cow's milk for human milk. The decrease in the typical nursling organisms is accompanied by an increase in the numbers of *B. coli* which then dominate the intestinal tract and form about 80 per cent., roughly, of the total living fecal organisms of adolescence, and which persist in this proportion in normal individuals until death.

B. coli differs from *B. bifidus* in one noteworthy respect. *B. coli* can grow equally well in media containing protein and utilizable carbohydrate, or in media from which utilizable carbohydrates are excluded. It can accommodate its metabolism to the varying foods presented to it in the intestinal contents. This plasticity of the colon bacillus and its ability to develop in the average intestinal contents, explains in a satisfactory manner the dominance of this organism throughout life.

Turning now to the distribution of bacteria in the intestinal tract of the normal adult, it is found that the stomach contents are practically sterile under normal conditions. When the hydrochloric acid acidity of the stomach contents becomes diminished through disease, it is found that the numbers of bacteria in the stomach contents may increase greatly. The duodenum also during those periods when it is empty is practically sterile. The bacteria population increases as duodenal digestion increases, and diminishes as the duodenal contents are passed on to the lower levels.

The greatest number of living bacteria is found in the region of the ileocecal valve and the ascending branch of the colon. Here the contents stagnate, as it were, and they eventually become so desiccated through the withdrawal of water that bacterial life is retarded.

The significance of the intestinal flora has been variously interpreted. Nuttall and Thierfelder delivered guinea-pigs by Cæsarean section and attempted to raise them in a sterile environment on sterile food. For two weeks these sterile guinea-pigs increased in weight and appeared to be reasonably healthy. These observers drew the conclusion that the intestinal bacteria were not necessary for the well-being of these guinea-pigs at least. These experiments were not accepted by Schottelius as being conclusive. He claimed that the experiments were not carried on long enough. Schottelius experimented with chicks hatched from sterile eggs divided into three groups. These were incubated under sterile conditions, and the chicks developing from one group were kept in an absolutely sterile environment and fed on sterile food; a second group were kept under the same conditions for ten days and then fed with infected food; the third group were controls and were kept under ordinary conditions. The first group, the sterile chicks, did well for ten days, but after that time their development was seriously retarded. The second group also did well for ten days, and then, as the first group began to exhibit signs of abnormalities, they were placed on infected food: they gained rapidly. The third group, kept under ordinary conditions, did well from the start. Schottelius believed that his experiments showed that the intestinal bacteria were necessary for the development and well-being of chicks.

Madame Metchnikoff made similar observations on tadpoles, and Moro performed the same experiments with turtles. These observers agree with Schottelius that the intestinal flora appear to be necessary for the well-being of the animals they experimented on.

A line of evidence which is somewhat different from this was brought forward by Levin. He examined the fecal contents of many Arctic mammals in the Arctic regions, and he found few or no bacteria in them.

Attempts have been made to sterilize the intestinal contents of man, either by administering sterile food or by the use of antiseptics, but this line of experimentation has not been successful.

From the individual point of view the intestinal flora under ordinary conditions are innocuous, and perhaps even to a moderate degree protective. But under abnormal conditions, when progressively pathogenic bacteria gain a foothold in the intestinal tract, the intestinal flora may become a menace to health and may become a matter of real concern to the health of communities.

The General Mechanism of the Action of Ferments—Enzyme Action: C. S. HUDSON.

A discussion of the chemical changes involved in the action of enzymes.

Use of Bacteria in the Treatment of Textile Fibers: F. P. GORHAM.

Microorganisms in Their Application to Agriculture: C. E. MARSHALL.

Professor Marshall's complete paper has been published in SCIENCE.

A. PARKER HITCHENS,
Secretary

SCIENCE

FRIDAY, SEPTEMBER 17, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

AMERICAN ACHIEVEMENTS AND AMERICAN FAILURES IN PUBLIC HEALTH WORK[1]

PUBLIC health work in America began early in the eighteenth century with the introduction into New England of the Oriental inoculation for small-pox by Boylston, and has achieved world-wide renown early in the twentieth century with the scientific sanitation of the tropical Isthmus of Panama by Gorgas. The educating, organizing and equipping with sanitary machinery of a swiftly growing population, at first sparse but later sometimes intensely congested, and always fluid and unstable under the pressure of migrations and immigrations such as the world has never seen, is in itself a great achievement. And when that population is, like ours, compounded of all the races of mankind, lodged in a new environment and subjected to an unfamiliar and quickly changeable climate, public health work becomes exceptionally difficult. Nevertheless, under leaders like Boylston and Waterhouse, Shattuck, Walcott and Billings, and Reed, Lazear and Gorgas—to whom we may now proudly add the name of Strong—sanitary information has been gathered and spread abroad and applied; vital statistics have been collected and studied; sanitary libraries have been formed; boards of health have been organized and directed; public health laboratories have been established; and epidemiology and other branches of sanitary science enriched and extended.

[1] Address of the President, American Public Health Association, Rochester, N. Y., September 7, 1915.

To these achievements various arms of the federal government have materially contributed, *e. g.*, the U. S. Public Health Service, the Department of Agriculture, the medical corps of the navy, and, especially, the army medical corps which through the splendid and eminently scientific labors of Reed, Lazear and Carroll and Carter and Gorgas have solved the deepest mysteries, and overcome the worst difficulties, of tropical sanitation. Drs. Blue and White and their associates of the U. S. Public Health Service have likewise earned the honor and gratitude of mankind by their proof that under proper administrative measures the bubonic plague of the Orient and the yellow fever of the Occident may alike be held in check in our own country, while, as we are meeting to-day, Strong, formerly a government official, but now in Serbia and Montenegro, representing various more private foundations, is winning fresh laurels for American public health measures. Thus the bold and brilliant epidemiological work of Boylston and Waterhouse which marked the beginning of experimental preventive medicine in the early eighteenth and early nineteenth centuries, has been continued and extended in the late nineteenth and early twentieth by their still more scientific successors. Some of our state and city boards of health and some of our private institutions and laboratories have likewise lent invaluable assistance, as for example the Massachusetts State Board of Health, the New York City Board, the Rockefeller Institute, and many others. Meantime, less original but not less enthusiastic and faithful work has been done by various associations for the promotion of the public health, such as the American Public Health Association, and the now happily numerous anti-tuberculosis societies, the organizations for the promotion of school hygiene, for the prevention of infant mortality, and the like. We have also, at last, in addition to a small but increasing number of creditable state, town and city boards of health, what is virtually a national board of health, namely, the U. S. Public Health Service—a highly scientific and efficient arm of the federal government, well organized, well equipped, and provided with a staff of able and devoted investigators.

Up to 1886, *preventive medicine* chiefly in the form of vaccination was the principal weapon for the promotion of the public health, and a long step forward was taken when in that year with a reorganization of the State Board of Health of Massachusetts, sanitary engineering became a recognized and indispensable branch of public health science and public health service. Since that time *preventive sanitation*, and particularly the sanitation of towns and cities in respect to water supplies, milk supplies, ice supplies, sewerage, garbage disposal, street cleaning, the heating and ventilating of public buildings, the smoke nuisance, and other environmental factors of public health or ill-health, has come to receive close attention and treatment. In the further development of preventive medicine and preventive sanitation, public health laboratories for the quick detection of dangerous infections have rapidly been installed almost everywhere in the more progressive American cities and towns. We have begun the medical and sanitary supervision of schools and school buildings. We have invented and put within the reach of all but the very poor, the most complete, convenient and salubrious heating and ventilating appliances in the world, for houses, theaters, halls, hotels and workshops. We have made ice, once a luxury for kings and emperors, a universal solace for all classes in hot weather. We have perfected and extended enormously the

preservation of foods by cold and by canning, so that seasonal food scarcity is almost unknown. We have invented and cheapened rubber clothing, and especially rubber overshoes, as a protection against our almost tropical rains. We have applied machinery to the manufacture of abundant and better and cheaper shoes and clothing. We have proved by experiment with a national spitting nuisance the possibility of sometimes controlling unsanitary habits by education and reasonable sanitary ordinances.

And yet—on the other hand—we have thus far failed to achieve many much needed sanitary improvements. Our water supplies are to a large extent either in good condition or on the way to improvement, but our sewage disposal systems are still in many cases far from satisfactory. In this respect the parallel between the individual and the community is close, for while many intelligent persons attend carefully to the water they drink, most are comparatively careless about their excretions, regarding as negligible that frequent and regular and complete output of the body wastes which is no less necessary for the conservation of health than is the intake of wholesome food and drink. The most flagrant failure in American sanitation to-day is the almost universal lack of public convenience or comfort stations in American cities and towns. The stranger within the gates of most American communities seeks in vain for any public sanitary conveniences. If he is well-dressed, he must be referred to hotels or other semi-public buildings or, if poorly dressed, to saloons or railway stations or other semi-private or public-service places. Some three months ago the leading newspaper of one of the proudest and most progressive cities of New England, which has since rejoiced to find itself "in the hundred thousand class," announced that its

> first public sanitary . . . was opened Saturday morning, and will be open daily hereafter from 6 A.M. until midnight. The opening . . . marked the end of ten years of effort to get such a comfort station built.

Failure like this to provide proper public toilet facilities for our towns and cities is to fail in one of the very elements of public health.

We have also failed to reduce typhoid fever as far as we should have done in America. Of late much progress has been made in the right direction but we need to remember that it is the last step that arrives, and we have always failed to attend closely enough to the single, as well as to the seemingly final, case. Like nature we are often "so careless of the single life, so careful of the race." We have failed likewise to reduce as far as we should have done American infant mortality. Here undoubtedly our hot weather works against us, but so also do our milk supply, which can be and ought to be rendered safe by pasteurizing, and our parental ignorance and incompetence, which can and should be lessened by education and the aid of public health nurses. We have as yet, and in spite of ample knowledge, failed to make our American milk supplies what they should be. This is partly because we have been too timid to insist that good milk not only costs more to make but is worth more for food, and must therefore be paid for, and partly because we have not yet taught the public as we should that the only safe milk is cooked milk, and for infants, milk that is pasteurized—preferably in the final container. I have myself lived through the last years of the period—now happily remote—when no milk was pasteurized by anybody; through the next in which only pioneers like Nathan Straus preached or practised pasteurization, while many if

not most, physicians, deprecated the practise; through the one following, in which the scales began to turn in favor of pasteurization; and into the present when almost no one fully informed on the subject actively opposes pasteurization. And yet, even to-day, some physicians are short-sighted enough to tolerate if not to recommend the general use of raw milk, which still constitutes the great bulk of the milk used by infants and adults all over the land. Such use of raw milk we must count as long as it lasts one of our worst public health failures.

We have also failed thus far to pay proper attention to our American climate, which has been well described by a popular writer as "polar-tropic." Placed as we of the United States are on the latitude of southern Europe, Persia, and the northern parts of Africa and Arabia, we are exposed alike to the stimulating and dangerous sunburn of the south and the cold dry winds driving down upon us from the continental area of Canada and the high north. In this fact perhaps we shall some day find one of the principal causes of that eager, strenuous, often nervous and sometimes excited, condition which we may call "Americanitis."

Another conspicuous failure is our rural and industrial hygiene and sanitation. With vast regions given over to rural life, and with other regions called industrial, small in area but teeming with life and noise, we have as yet only touched the surface of the public health problems involved. The same is even more true of the problems of alcoholism and venereal disease. Here we shall probably learn by comparison with the spitting evil that it is easier to overcome habit than to conquer appetite, and we must be prepared for delays and disappointments yet without giving up hope.

Some streets of most American cities are often disgracefully dirty and untidy. Horse-dung and other dirt, dust, papers, fruit skins, old hats, abandoned umbrellas, discarded shoes and the like are too often seen lying about our streets. Yet these same streets are the principal playgrounds of the poor, and ought for every reason to be kept scrupulously clean. We have devised excellent apparatus for heating and ventilating halls and houses in our polar winters but have neglected the almost equally important problem of cooling habitations and public buildings in our tropical summers. We have not done all we might do for the prevention of blindness, of tuberculosis or of cancer. Our vital statistics are not yet either complete or trustworthy; our health boards are too often loaded up with political refugees, political doctors, and ignorant or incompetent laymen. Our health officers are frequently untrained, ill-paid, or only part-time employees of a no-time board.

But above all I must put our almost complete neglect of *preventive personal hygiene*. From 1720 to 1886 we had little to show in public health work beyond vaccination for small-pox—the fundamental procedure of *preventive medicine*. To this, which has since expanded immensely in various directions, we have added *preventive sanitation*, by which I mean the purification of water and sewage and milk, the control of mosquitoes to guard against malaria and yellow fever, improved housing, and many other fundamentals of a sanitary environment. But we have not yet even begun to demand that study and care of the *individual* which is the most fundamental of all public health problems. We have paid little or no attention to the prevention of overeating, overworking, overdrinking, deficient exercise and deficient sleeping, to family hygiene, and the hygiene of

special organs such as eyes, ears, bowels, teeth, nose and feet—all of which I propose to group together under the term *preventive hygiene.* We have achieved much in preventive medicine and preventive sanitation, but we have as yet failed for the most part in preventive hygiene, which is very likely the most important of all. Here, therefore, we may reasonably expect the greatest progress in the nearest future. Rightly studied, preventive hygiene will include personal, domestic, family and social hygiene. It will deal with celibacy and marriage, with sanitary house-keeping, with the high cost of living, with food economy, with domestic service, with child hygiene, and with the proper conduct of mature and elderly life, as well as with the manifold aspects of strictly personal hygiene. It will in the future play perhaps the principal part in solving many of the problems of American life, health, prosperity and happiness.

Our whole teaching of hygiene and sanitation has been grossly neglected, and our teaching of physiology on both the higher levels and the lower has never emphasized as much as it should have done its practical hygienic applications to the conduct of life. Even our best medical schools have paid but scant attention to these subjects, while the instruction given in the public schools has hitherto suffered from uninformed school committees and half-informed teachers. The best teaching of to-day is to be found, not in the text-books or the schools, but in the leaflets issued and distributed by certain leading boards of health and life insurance companies. Surely this is a scholastic reproach which should not be allowed to stand.

In conclusion I desire to express my appreciation of the honor conferred upon me by the gift of the office which I hold. The American Public Health Association is to-day a splendid force in the land. Its *Journal,* under the able editorship of our devoted and faithful secretary, Professor Gunn, is worthy of the great and truly international body which it represents. It is your duty and mine to strengthen Professor Gunn's hands, to increase our membership and help on the good work which is being done. If the Association continues to grow in numbers and in influence along the broad paths already marked out, remaining always democratic rather than bureaucratic, it will be worthy of the great name—"American"—which it bears. Two of our component members, the Dominion of Canada and the Republic of Mexico, are bearing the heavy burdens of war—the one foreign, the other civil. Both have the liveliest sympathy of their confreres in this association. It may seem to some as if, under the shadow of a war characterized as never before by the destruction of life, efforts for its conservation through hygiene and sanitation must be of little moment. But it is not so. "After the clouds the sun": and we believe that after the present bloody conflicts are ended—and may that time quickly come—the races of mankind will turn, as never before, and with new longing, to the nobler pursuits of life, liberty, health and happiness. When that better day dawns the eternal principles underlying the conservation and promotion of normal life and health will once more move and quicken the nations as sunshine warms and quickens the earth after storm. Meantime, we must make ready for active and intelligent dealing with the thousand new and pressing problems which the present conflicts are certain to bring before us. And to this task we turn with cheerful courage.

W. T. SEDGWICK

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A SIMPLE METHOD OF INDICATING GEOGRAPHICAL DISTRIBUTION

There are two ways in which the distribution of plants and animals on the surface of the earth may be expressed. The first is in terms of countries or provinces or their subdivisions. To this there are several objections: (a) The boundaries of a country or province or county are frequently very irregular and do not follow any definite direction. These areas are, moreover, as a rule, very unequal in size. (b) The boundaries of countries which have a different form of government are unstable and are liable to change. This has frequently happened already within the memory of men still living and is likely to happen again in the near future. (c) The method is only applicable to land areas. It can not be applied to the fauna and flora of the oceans.

The second method is one which has not been much used so far but is much more scientific and exact. It is that of indicating the range of a plant or animal in terms of latitude or longitude. However important international boundaries may be from the human standpoint they have no meaning to plants and animals—unless indeed they should happen to coincide with some natural boundary, such as a mountain range or an expanse of water. But the parallels of latitude and the meridians of longitude are so numerous that it is difficult to remember the particular countries traversed by any one of these in its course. While most people know that the forty-ninth parallel forms the northern boundary of the western half of the United States, very few indeed could name the states traversed by the fortieth parallel.

The method suggested here is a modification of the second of the above. It is proposed to divide the whole earth's surface into a series of areas bounded by the parallels and meridians. Each of these areas will be more or less rectangular, but only two of the four sides will be actually parallel. The size of the areas will gradually diminish towards the poles, but those within the same latitude will be of equal area. Each "merosphere" will have a definite number attached to it and will be capable of division into smaller areas, each of these ultimate units measuring one degree of latitude by one degree of longitude. The size of these proposed primary areas or "merospheres," as I have called them, will be a matter for legitimate discussion. If too small they will be so numerous as to have no advantage over the method of expressing distribution in terms of latitude and longitude. If, on the other hand, they are too large they will be useless for indicating distribution. The actual size proposed here measures six degrees of latitude by nine degrees of longitude. The reason for the adoption of these figures is twofold. It is true in a general sense that isotherms or lines of equal mean temperature run for the most part east and west unless where deflected by mountain chains or sheets of water when they may run in any direction, even north and south. It is also true, in a general sense, that the temperature falls steadily from the limits of the tropical region towards the limits of the polar regions. While there are wide variations in different continents, I have taken the rate of fall as being on the average about 1½° F. for every parallel of latitude. Six degrees of latitude will therefore correspond to about 9° F. or 5° C.

If the width of the proposed areas were 6° of longitude instead of 9° these areas in the neighborhood of the equator would be approximately squares, but would be narrow towards the poles. By making the width of the proposed areas 9° instead of 6° squares will occur about midway between the equator and poles and the number of areas or "merospheres" will be proportionately reduced.

The details of the proposed scheme are as follows: Beginning at the equator, the northern half of the earth is divided into fifteen parallel belts, each comprising 6° of latitude. These are numbered consecutively from N 1 to N 15. The southern hemisphere is divided similarly into belts S 1, S 2, etc. Each belt is divided into 40 divisions beginning at the meridian of Greenwich, the numbers running consecutively westwards until the meridian of Greenwich is again reached. As mentioned above, each division comprises 9° of longitude.

The belt number can conveniently be distinguished from its division numbers by a dot placed between them. Thus the state of Georgia would be included for the most part in N 6.10 with the extreme eastern area in N 6.9. The island of Tasmania would be comprised in S 7.17 and S 8.17.

Subdivided in the above manner, the United States would be comprised in belts N 5 to N 9 and would be contained in 29 divisions.

The above-defined areas, though large, are sufficient to indicate in a general way the distribution of plants and animals. But where greater exactitude is required, as, for example, where it is desired to indicate the most southerly point reached by a typical northern species or *vice versa* they are rather vague. Accordingly each "merosphere" may be again divided into smaller areas, each consisting of one degree of latitude and one degree of longitude. As will be seen from the annexed figure the east and west sub-belts are numbered from 1 to 6 and the nine strips running north and south are marked from A to I. By the com-

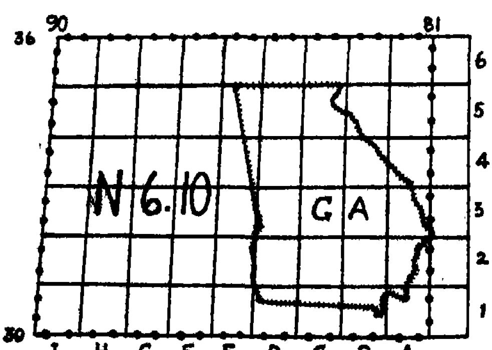


FIG. 1.

bination of a number and letter the position of each of the 54 subdivisions can be indicated, thus N6.10.5E will include the northwest corner of Georgia. One advantage possessed by the system of numbered areas herein described is that it can be used alone or in conjunction with the name of the state or province where fuller information is desired. Thus Georgia (N6.9.3I) will indicate the area around Savannah. Altogether this state contains twenty-four of these smaller subdivisions.

If some such scheme of uniform subdivisions were adopted in the case of a "flora" which deals with a single state or country the separate units of adjacent states or countries could readily be grouped into the larger areas mentioned.

It must, of course, be borne in mind that some such scheme as the above is intended to indicate only the *geographical* range of species. The division of the earth's surface into *biological* provinces, each with its characteristic assemblage of plants and animals, is a different matter. Before we can divide the earth satisfactorily into biological areas we must know first the actual limits of distribution of each species as well as something of the climatology in the widest sense of the proposed areas. At present we have not amassed sufficient data to enable us to make these wide generalizations, though several persons have made the attempt with varying success.

The need for some such division of the earth's surface, as I have attempted to outline above, is not so evident in the United States as it is further north. Such terms as Labrador, Alaska and Ontario, referring as they do to very large areas, are too indefinite to indicate with exactness the distribution of the fauna and flora. Labrador formerly had a different meaning from what it has at present, the greater part of the territory formerly called by that name being now part of the province of Quebec, and even yet the boundary line is not properly delimited.

The distribution of a certain species is given in the "North American Flora" as "Nova Scotia to Georgia, Tennessee and Michigan." Presumably it occurs in Ontario, as a line drawn from Nova Scotia to Michigan will pass through the province of Ontario. But it is not by any means certain whether the species occurs in the southern parts of New Brunswick or Quebec. According to the method outlined above the distribution would be N6.9–10, N7.8–10, N8.8–10.

Another species is mentioned as extending "from Newfoundland to Florida, Alabama and the Mackenzie." As this river has a course of over 1,000 miles in length it will be

evident that it is a somewhat indefinite boundary line.

To express the distribution of any species it ought to be sufficient to enumerate the divisional numbers of the areas in which it occurs and its ultimate limits to the north and south and in an easterly and westerly direction. Range of altitude in each division, or at any rate in each belt, is of as much importance as range in latitude.

J. Adams

Central Experimental Farm,
Ottawa

THE COMMITTEE OF ONE HUNDRED OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE SUBCOMMITTEE ON THE SELECTION AND TRAINING OF STUDENTS FOR RESEARCH

At the meeting of the Committee of One Hundred of the American Association of Scientific Research in April, 1914, the chairman was authorized to appoint a subcommittee on the Training and Selection of Students for Research. He subsequently appointed the following members: Professor R. A. Harper, Columbia University; Professor R. G. Harrison, Yale University; Professor G. A. Hulett, Princeton University; Professor W. Lindgren, Massachusetts Institute of Technology; and Professor E. W. Brown, Yale University, chairman. This subcommittee has conducted its discussion mainly by correspondence, but held a meeting on May 14 last at which four of the members were present. The report which follows is signed by these four members of the sub-committee; Professor Harper, being absent from the meeting and being unwilling to sign the report, resigned.

The education of students naturally is divided into school, undergraduate and postgraduate instruction. The first of these is too large a question to touch on in this connection. The third on the whole is well organized, and at the present time practically consists only of students intending to take up research or those needing the higher degrees for educational careers. Hence most of the work of the sub-committee was in the direction of considering what might be done to further the interests of the abler students in their undergraduate careers. In using the phrase "abler students" the subcommittee had in mind the upper twenty to thirty per cent. of the classes.

In order to find out what was done in the various colleges and universities of the United States a circular was sent out to about forty, which were considered representative of the various systems of instruction throughout the country. This circular inquired what facilities were provided for the more able amongst the undergraduates for furnishing them with a better and more rapid training than the ordinary student. If such facilities were offered, inquiry was made as to what form these facilities took. It was also asked whether any money rewards were given for high attainments, and whether the institution had any knowledge of the results obtained from these facilities. About thirty of the forty selected institutions sent replies sufficiently detailed for the subcommittee to obtain a fair idea of what was being done throughout the country in this connection. It appears that five universities have specially organized courses in which the better students are able to have greater facilities for progress than the majority. Two others have courses laid out without, however, appearing to put much stress upon them. The remainder have little or nothing organized. These organized courses are generally referred to as "honors courses." Practically all of the institutions adopting them use the same methods, consisting of segregation into separate classes, extra work in connection with the ordinary courses, a limit for admission to such courses, a general final examination, less class-room work, and a complete program for junior and senior years. These different methods depended on the particular department, much freedom being given to the various departments. A fair idea of the various plans adopted may be gathered from the catalogues of the universities of Columbia, Minnesota, Princeton and Yale. Princeton has the preceptorial system in addition, but the expense of this makes it of doubtful value for

most institutions and it is not considered essential.

The subcommittee approves in general of these methods of looking after the interests of the abler students and strongly recommends that equivalent plans be made by all institutions of collegiate rank. As stated above, these methods refer to the work in junior and senior years. In freshman and sophomore years, where many classes are large enough to be taken in sections, it is recommended that the sections be formed according to the ability of the students as early as this can be ascertained. In this manner the best students will be able to advance more quickly and so be better prepared for the special arrangements for the later years. The subcommittee feels that in the past nearly all the time and energy of the instructor has been given to the lower end of the class, and that in consequence, the upper end has seriously suffered. While it may be true that a certain amount of stimulus is given to the whole class by the best men, the loss to the latter far outweighs any possible gain that might accrue to the majority from the presence of these men in the classroom. The latter often leave college with diminished powers if increased knowledge, having never felt the need of making great efforts in order to accomplish what is asked of them. The result is a serious loss of time and efficiency even for those who later take up professions which demand hard and concentrated work. The loss to the community is even more serious, particularly in respect of the number of men who will not make new efforts to develop their full capacities. The real interests of the nation are better served by giving to the upper twenty per cent. of the class an education suited to their abilities than by allowing these abilities to be frittered away for the sake of a doubtful gain to the remaining eighty per cent. In any case, it is not likely that the education of the latter will suffer under the democratic principles of our government.

As to the methods to be adopted, the subcommittee favors segregation into separate classes as in general the best. The question, however, of expense to the institution arises. This can be met in several ways. In most departments elective courses are given which are taken only by a few students. The majority of these are naturally the best students in the department, but there are generally a certain number who take an elective for other reasons. It is recommended that the latter be excluded unless their previous work is of high grade so that these courses may be confined to the best students. It will be found in most cases that a considerable number of the elective courses can be so confined without serious loss to the rest of the students. Where this plan can be adopted no new expenditure for extra courses will be incurred. The excluded students will choose from the remainder of the list of electives, which, in the larger institutions at least, is greater than the needs of those who are not making a serious study of the subject demand.

In some subjects where segregation is not feasible extra work can be assigned, but this work should be carefully laid out and published in the catalogue as an essential part of the honors course and not left to the momentary inclination of the instructor.

Many institutions report that their instructors give extra time to promising students. While in isolated cases much benefit is derived by the students, it is not recommended as a permanent plan. Additional work for which he receives no compensation is laid on the instructor already overburdened with teaching, and an incentive from competition to most of the better students is lacking.

Harvard University reports that it has no specially organized plans for the interests of the abler students, but that many of them are able to take advanced courses in their undergraduate years because there is no sharp line of distinction between graduate and undergraduate courses. This method has been adopted for several years in some of the larger institutions with fully organized graduate departments, but it is not possible for the great majority of the colleges.

A final examination covering the whole of the special work for the honors course is advisable, and a considerable amount of stress

should be laid on the results. The subcommittee recommends that the question of outside examiners for this purpose be seriously considered. These examiners would set the papers but not necessarily examine the answers of the students. It was pointed out that with the system of outside examiners there is a considerable degree of cooperation between the student and his instructor. The papers should deal mainly with the general principles and fundamental facts of the subject, and only rarely with questions of detail in special portions of the subject.

The subcommittee also believes that the courses might very properly include one or two subjects in each department for which no class-room instruction is provided.

It is believed that the effect of these methods will be greater progress and more thorough instruction to the better students in the fundamentals of all subjects. A higher degree of stimulation to work and to take an interest in scientific pursuits will undoubtedly result, so that greater numbers with better training will be induced to enter the graduate schools and to take up research as a permanent career. These students will also feel that their work is of value to them and will not search outside for opportunities to make use of their powers.

The subcommittee obtained reports on the systems adopted in Germany, France and England. It did not appear that, at the present stage of American education, a close examination of the systems of Germany and France would be useful to the work of the committee. They are highly organised from the bottom to the top. In Germany and France admission to the university is gained by a difficult examination which eliminates the majority of those who can not obtain real profit from university courses. In German universities almost no pressure of any kind is brought to bear on any students good or bad, except by means of the final examination and the thesis. At Cambridge and Oxford the honors schools have long been definitely established. About forty per cent. of the students enter them and they receive separate instruction from the outset. Until the last two decades, but little thought was given to the work of the remaining sixty per cent., but the interests of the latter have recently been seriously considered and much improvement has been made.

A difficult situation is brought about by the student having no knowledge of his after career during his undergraduate course, so that he is not able to choose his line of work effectively. While vocational training is not in question in this connection, all the training for scientific work needs thorough and broad foundations. If the student has a knowledge of his after career he is able to choose his course so that these foundations may be well and truly laid. It is recommended, therefore, that advice be given to all students in college to choose their careers as early as possible.

The majority of those who expect to do research look to positions in colleges and universities in order to earn a living. Information should be given them as to research positions in the government service and also those in industrial laboratories. Work under the government appears to be somewhat better paid than that in the collegiate world, but there is some limitation on the problems which may be taken up for research. In the industrial laboratories these differences are still greater.

It is recommended that students be encouraged to change their institution between the undergraduate and postgraduate work. A greater breadth of view is desirable. It is also recommended that students be encouraged to choose their university for postgraduate work on account of the quality of the men in the subject rather than for other reasons. Much can be done by the advice of the undergraduate teaching body in this respect.

The subcommittee was only able to deal with these questions as far as the colleges and universities were concerned. Some information was forthcoming as to the situation in the technical schools, but it did not feel itself in a position to undertake this part of the work. It recommends that a new subcommittee consisting of a fuller representation of those connected with technical instruction be appointed to consider what measures should be taken to secure the objects in view.

THE NAVAL ADVISORY BOARD OF INVENTIONS

THE secretary of the navy has announced the membership of the Naval Advisory Board of Inventions which consists of twenty-three members, including Mr. Thomas A. Edison, who was selected by Mr. Daniels to serve as the presiding officer of the board. The other twenty-two members of the board who were chosen by ballot by eleven scientific societies invited by the secretary of the navy are:

American Chemical Society.—W. R. Whitney, Schenectady, N. Y. Massachusetts Institute of Technology, '90. Director of Research Laboratory of the General Electric Company. L. H. Baekeland, Yonkers, N. Y. University of Ghent, '82. In private chemical practise.

American Institute of Electrical Engineers.—Frank Julian Sprague, New York City. Naval Academy, '78. Consulting engineer for Sprague, Otis and General Electric Companies. B. G. Lamme, Pittsburgh. Ohio State, '88. Chief engineer of Westinghouse Electric and Manufacturing Company.

American Mathematical Society.—Robert Simpson Woodward, Washington, D. C. Michigan, '72. President of Carnegie Institution. Arthur Gordon Webster, Worcester, Mass. Harvard, '85. Professor of physics, Clark University.

American Society of Civil Engineers.—Andrew Murray Hunt, New York City. Naval Academy, '79. Consulting engineer. Alfred Craven, New York City. Naval Academy, '67. Chief engineer of public service commission and formerly division engineer in charge of construction work on Croton aqueduct and reservoirs.

American Aeronautical Society.—Matthew Bacon Sellers, Baltimore, Md. Lawrence Scientific School. Director of Technical Board of the Aeronautical Society of America. Hudson Maxim, Brooklyn, N. Y. Ordnance and explosive expert.

The Inventor's Guild.—Peter Cooper Hewitt, New York City. Inventor. Thomas Robbins, Stamford, Conn. Princeton. President of Robbins Conveying Belt Company.

American Society of Automobile Engineers.—Andrew L. Riker, Detroit. Vice-president of Locomobile Company. Electrical and mechanical engineer. Howard E. Coffin, Detroit. Michigan, '96. President of Hudson Motor Car Company.

American Institute of Mining Engineers.—William Laurence Saunders, New York City. Pennsylvania, '76. Chairman board of directors, Ingersoll-Rand Company. Benjamin Bowditch Thayer, New York City. Harvard, '85. President of Anaconda Copper Mining Company.

American Electro-Chemical Society.—Joseph William Richards, South Bethlehem, Pa. Lehigh, '86. Professor of electro-chemistry, Lehigh University. Lawrence Addicks, Chrome, N. J. Mass. Inst., '89. Consulting engineer for Phelps, Dodge & Co.

American Society of Mechanical Engineers.—William Leroy Emmet, Schenectady, N. Y. Naval Academy, '81. Engineer with the General Electric Company. Spencer Miller, South Orange, N. J. Worcester Polytechnic, '79. Inventor.

American Society of Aeronautic Engineers.—Henry Alexander Wise Wood, New York City. Engineer and manufacturer of printing. Elmer Ambrose Sperry, Chicago. Cornell, '76. Founder of Sperry Electric Company.

SCIENTIFIC NOTES AND NEWS

KARL EUGEN GUTHE, professor of physics in the University of Michigan and dean of the Graduate School, died on September 11, following a surgical operation. He was born in Hanover, Germany, on March 5, 1866.

JOHN HOWARD VAN AMRINGE, dean of Columbia College and professor of mathematics until his retirement five years ago after a service of fifty years, died on September 10, at the age of seventy-nine years.

THE Institution of Mining Engineers will present the institution medal for 1914–15 at its twenty-sixth annual general meeting, to be held at Leeds in September, to Dr. John Scott Haldane, F.R.S., of Oxford, in recognition of his investigations on mine air.

PROFESSOR JULIUS ELSTER and Professor Hans Geitel, who have carried on conjointly

experiments in physics and have published together over one hundred and twenty papers, have received honorary doctorates from the University of Göttingen.

Dr. Pircher has been made acting director of the Austrian Meteorological Bureau in succession of Professor Trabert, who has retired on account of his health.

Dr. Wilbur A. Sawyer, director of the State Hygienic Laboratory and lecturer in hygiene and preventive medicine in the University of California, has been appointed a member of the California State Board of Health and secretary of the board. As executive officer of the board he will have under his direction seven bureaus—Administration, Vital Statistics, Tuberculosis, and Registration of Nurses, with headquarters at the capitol, Sacramento; and the State Hygienic Laboratory and the Bureaus of Sanitary Engineering and of Food and Drugs, maintained by the state at the University of California.

Associate Professor Charles Riborg Mann, of the department of physics in the University of Chicago, has been granted by the university board of trustees an extension of his leave of absence for one year from October 1, in order that he may complete his survey of technical instruction in the United States, which he has undertaken under the auspices of the Carnegie Foundation for the Advancement of Teaching.

Mr. M. T. Dawe, lately director of agriculture, British East Africa, has been appointed agricultural adviser to the government of Colombia.

Professor Haendel, director of the Hygienic Institute in Saarbrücken, has been appointed director of the Imperial Health Bureau, Berlin, succeeding Professor Lentz.

Professor W. Morgan, who fills the chair of automobile engineering in the faculty of engineering of the University of Bristol, has been released from his duties for the period of the war to engage in work in connection with the production of munitions.

Surgeon Victor G. Heiser, U. S. Public Health Service, formerly commissioner of health, Philippine Islands, has arrived in New York. He has returned to the United States to make a report to the Rockefeller Foundation of his investigations in the Philippines and India of hookworm and other diseases.

Professor F. Cajori has resumed work at Colorado College after spending the past year abroad. He attended the Napier Tercentenary in Edinburgh and later traveled in France, Italy, Switzerland and Germany. The larger part of the year was spent in Oxford, Cambridge and London, where he was engaged in researches on the history of certain branches of mathematics in Great Britain during the seventeenth and eighteenth centuries.

Dr. E. S. Moore, professor of geology and mineralogy of Pennylvania State College, has returned from a year's leave of absence after attending the meeting of the British Association for the Advancement of Science in Australia and visiting several countries on geological excursions. The countries visited included New Zealand, India, Egypt and France, the last six months being spent chiefly in study with Professor Lacroix at Paris.

News has reached England of the Easter Island expedition of Mr. and Mrs. Scoresby Routledge up to June 8, at which date the expedition had been fourteen months in residence, during which time a careful survey had been made of the existing antiquities and such ethnographical information collected as is still available.

The twenty-fourth annual session of the Association of Military Surgeons of the United States was held in Washington on September 13 to 15, under the presidency of Col. J. R. Kean.

We learn from *Nature* that in addition to his name being expunged from the list of honorary members of the laryngological societies of Vienna and Berlin, in consequence of his having protested in a letter to the *Times* against the alleged barbarities of Germany in the war, the name of Sir Felix Semon has been removed from the *Internationales Centralblatt für Laryngologie*, which journal he founded twenty-five years ago. In consequence of this action, all the British editorial contributors to

the *Centralblatt* who have had an opportunity of seeing the declaration have withdrawn their names from and resigned their editorial connection with it. Among these are Dr. Peter McBride, Dr. H. J. Davis, Dr. Logan Turner and Dr. Watson-Williams. Their American collaborator, Dr. Emil Mayer, has also severed his connection with the journal.

A BRONZE bas-relief—the work of Mr. S. N. Babb—is about to be erected in St. Paul's Cathedral in memory of Captain Scott and his companions who perished in the Antarctic. At the request of the committee responsible for the memorial an inscription has been written by Lord Curzon, which reads as follows: "In memory of Captain Robert Falcon Scott, C.V.O., R.N., Dr. Edward Adrian Wilson, Captain Lawrence E. G. Oates, Lieut. Henry R. Bowers and Petty Officer Edgar Evans, who died on their return journey from the South Pole in February and March, 1912. Inflexible of purpose, steadfast in courage, resolute in endurance in the face of unparalleled misfortune. Their bodies are lost in the Antarctic ice. But the memory of their deeds is an everlasting monument."

DR. DONALD MCINTOSH, professor of veterinary science at the University of Illinois, died on September 5, at his summer home in Portland, Me. Dr. McIntosh was elected to his permanent position in June, 1886. At that time the total faculty of the university numbered but twenty-seven, of whom only Dr. Burrill, Professor Ricker, Professor Rolfe, Professor Baker and Professor Forbes are left.

THE death is announced at the age of eighty-eight years of Mr. F. Manson Bailey, colonial botanist for Queensland from 1881 until within a short time of his death.

DR. J. J. T. QUENSEL, professor of pathological anatomy at the University of Upsala, has died at the age of seventy years.

DR. RICHARD KIEPERT, the German cartographer, has died at the age of sixty-nine years.

CAPTAIN W. E. G. ATKINSON and Captain Arthur Kellas were killed at the Dardanelles on August 6. The former was known for his experimental work on varieties of wheat, the latter for work in psychiatry and physiology.

LORD BRABOURNE has been killed in the war in the twenty-ninth year of his age. He had returned recently from South America where he was collecting material for the work on "The Birds of South America" which he was writing in conjunction with Mr. Charles Chubb and of which one part had appeared.

THE Berlin correspondent of the *Journal* of the American Medical Association writes that the "Langenbeck-Virchow Haus," built by and for the Berlin Medical Society and the German Surgical Association was opened on August 1. The ceremonial opening was postponed until after the conclusion of the war. The auditorium, three stories high, has a seating capacity of 900. The galleries have a seating capacity of 335. The room is lighted by day through a skylight and in the evening by eighteen electric arc lamps of 25,000 candle power. The auditorium is 13 meters high, 24 meters long and 17.5 meters wide. Artificial ventilation is provided for so that the air may be renewed every hour. On the first floor is a smaller hall with a seating capacity of 200. Both rooms are provided with epidiascopes and kinetoscopes and can rapidly be darkened. Small rooms, contiguous to the auditorium, are provided for waiting rooms for patients, and in one a small laboratory has been installed. The reading room and library, containing 200,000 volumes, is on the third floor. One small room contains the library bequeathed to the Berlin Medical Society by Virchow. The larger reading room is furnished with twenty-five tables at each of which two may be seated. Other small rooms are provided for such readers as wish to work quietly and undisturbed. Refreshments may be had on the first floor. Stores occupy the first floor front, and will be rented to concerns identified with medicine, such as instrument houses, book dealers, etc.

UNIVERSITY AND EDUCATIONAL NEWS

GUY'S Hospital has received $125,000 from the trustees of the will of the late Sir William Dunn for the endowment of a lectureship in pathology in the Guy's Hospital Medical School, to be known as the "Sir William Dunn Lectureship in Pathology."

The registration for the fall term at the University of California by September 3 had reached a total of 5,551, as compared with 5,236 on a corresponding date in 1914. Graduate students at that date numbered 742 as compared with 632 on a corresponding date the previous year. Including the summer session of 1915, which enrolled more than 5,400, and the students in the colleges of medicine, dentistry, pharmacy and law, but excluding students of the university farm school, the university extension division, the Wilmerding Trades School, and of the San Francisco Institute of Art, the University of California's registration for the present academic year is expected to exceed 11,000.

The department of sociology and anthropology, University of Minnesota, has been reorganized with Dr. Albert Ernest Jenks as chairman; Dr. Arthur J. Todd, professor of sociology; Dr. Paul I. Neergaard, instructor in sociology; Mr. Frank J. Bruno, lecturer on poverty; Mr. Otto W. Davis, lecturer on housing; Mr. Charles C. Stillman, lecturer on poverty. Dr. Jenks has been professor of anthropology in the University of Minnesota for nine years. All the other members of the department are new men in the university. Dr. Todd comes from a professorship of sociology in the University of Pittsburgh; Dr. Neergaard was last year instructor in sociology at Western Reserve; Mr. Bruno is secretary of the Minneapolis Associated Charities; Mr. Davis is housing expert with the Minneapolis Civics and Commerce Association; and Mr. Stillman is secretary of the United Charities of St. Paul. The president of the university, Dr. George E. Vincent, will contribute a course of lectures on "Aspects of Social Psychology." Dr. Joseph Peterson, another new member of the faculty, and professor of psychology, offers a semester course of lectures on social psychology for the department of sociology and anthropology. Another new course of lectures will be presented by experts in collaboration from the several detention institutions of the state. It is the plan of the department to emphasize practical courses to equip the students for life in the extensive rural states which stretch westward with Minneapolis as their gateway.

Dr. Chas. H. Otis, for the past two years instructor in botany in the College of Arts and Sciences of Cornell University, has accepted a position in the botanical department and experiment station of the New Hampshire College.

Dr. Anschultz, docent in the Hamburg Scientific Institute, and Dr. Demoll, professor of zoology in the Karlsruhe Technical School, have accepted calls to professorships in the university at Constantinople, the former in psychology and the latter in zoology.

DISCUSSION AND CORRESPONDENCE

CALIFORNIA AND STANFORD MISREPRESENTED

In the Ninth Annual Report of the Carnegie Foundation for the Advancement of Teaching which has just come to my attention, "the two great universities of California" are accused of having lent themselves "to the perpetuation of the medical rivalry which has so long existed in San Francisco." Mr. Pritchett rightly adds, "The world has a right to expect a better solution than this and one more in accordance with the largeness of true university relationship." The solution referred to by Mr. Pritchett is the question of fusion of the two university medical schools.

Were such a grievous charge against our universities justified, every right thinking man would agree with Mr. Pritchett that this *is*, not merely *seems*, "a matter of regret from every point of view." Since this charge has been given such wide circulation and especially since the distinguished board of trustees of the foundation, by virtue of their office, would seem to stand sponsors for Mr. Pritchett's sweeping indictment, I must record my earnest protest against so unfounded a charge. That any one animated solely by a desire to know and to understand the relations and aims of our universities could so wholly misunderstand and misrepresent them, is as regrettable as it is surprising. It is perplexing, indeed, to imagine where Mr. Pritchett found evidence to prompt such a serious reflection upon the good name of California and Stanford.

I have been in California only six years—happy years—but these six years more than cover the period during which the fusion of the two university medical schools has been under consideration. During this period the universities have not lent themselves to so unworthy a purpose. The institutional relations have been friendly, indeed, and a spirit of cooperation has prevailed throughout. This is in keeping with the spirit of the west. The disregard for little things, the helping hand and feeling heart, are the legacy of pioneer days just passed. Besides, there really is very little occasion or basis for unseemly inter-university rivalry. Stanford set its limits regarding enrollment and is maintaining them, and with an attendance of 7,000 *our* state university surely is not lacking in numbers. Every year some of our medical students are advised to attend the California summer school, not only in the non-medical, but in the medical subjects as well. We accept each other's records without hesitation or question and also encourage students who desire to do so to go elsewhere. We have trusted each other and the rewards of this trust have, I believe, been ours. The spirit of reciprocity prevails. We Stanford men were not all "to the manner born" but we are citizens of California and as such have faithfully espoused the best interests of our state university. More than a score of us are alumni of California, whose faculty also contains a number of Stanford graduates. Besides, many members of the faculties of the neighboring universities have a common alma mater. Larger appropriations and opportunities for California neither alarm nor threaten us. If we have not decided to merge the medical, law or engineering schools or even our universities, that is no reason why our motives should be impugned. Moreover, to my knowledge the faculty of Stanford University has never even considered such a fusion and the University of California must in this matter speak for itself. The subject, to be sure, has been considered in the administrative boards and may, I presume, be considered again, for I believe that the same good will animates them.

It is strange, indeed, how Mr. Pritchett can call our universities "great" and our medical schools "strong" if the alleged spirit prevails, for that way, surely, only weakness lies. Mr. Pritchett's characterization of the field of modern medicine as *"so narrow"* is decidedly enlightening. Other statements in Mr. Pritchett's report call for comment but I shall forbear. The future will be Mr. Pritchett's and our sternest judge. I trust, however, that a sense of justice will cause Mr. Pritchett to give an explanation for his unqualified accusation, and since the great usefulness and influence of the foundation must in time be seriously jeopardized by such uncorrected errors, I further trust that the board of trustees of the foundation will disclaim responsibility for so serious and so unjust a reflection upon the good name of the two universities.

"Those principles of peace and conciliation which President Jordan has so eminently represented" are indeed being maintained between the two universities, and if I may reciprocate Mr. Pritchett's wish, I hope that the same principles of peace and conciliation which Mr. Carnegie has so long and so ardently espoused will more and more pervade the spirit and temper of the verdicts of the Foundation for the Advancement of Teaching.

A. W. MEYER

PALO ALTO, CALIFORNIA,
August 4, 1915

SUCCESSFUL LONG-DISTANCE SHIPMENT OF CITRUS POLLEN

IN connection with investigations in Japan in the spring of 1915, Mr. Walter T. Swingle, physiologist in charge of crop physiology and breeding investigations, Bureau of Plant Industry, found it desirable to make an attempt to breed canker-resistant[1] strains of grapefruits and tangelos by hybridizing with the more resistant Japanese races of pumelo (Buntan) and other late-ripening, large-fruited citrous fruits commonly grown in Japan. He accordingly cabled for grapefruit and tangelo pollen.

[1] Hasse, Clara H., "*Pseudomonas citri*, the Cause of Citrus Canker," *Jour. Agric. Research*, Vol. 4, pp. 97–100, Pls. 9, 10, April, 1915.

Previous experiments had shown that it was possible to use pollen from flower buds which had been gathered when just ready to open and kept in cold storage until needed, but after five to seven days the buds discolored and moulded. Pollen had been sent in this way from Florida to California, but for a long period of time such as the duration of the voyage from Florida to Japan, it was necessary to develop other methods.

The attempt was first made to brush the pollen[2] from the anthers into small vials, but this process was abandoned for the much quicker method of putting the anthers entire into the vials. The preparation of the pollen may be divided into four methods, as follows: I., pollen in cork-stoppered vial; II., anthers in vial with cotton stopper; III., anthers in vacuum glass tubes, *i. e.*, tube filled with anthers for 1–2 inches, cotton ½ inch, then exhausted to about 10 mm. pressure and sealed; IV., anthers in dried vacuum glass tubes, *i. e.*, tube filled with anthers 1–2 inches, cotton ½ inch, exhausted to about .5 mm. pressure in the presence of sulfuric acid, the tube then sealed. As far as practicable the pollen was kept at a temperature of 10° C. until sealed.

Through the courtesy of Director Onda of the Imperial Horticultural Experiment Station at Okitsu, Shidzuoka Ken, Mr. Swingle made arrangements to test the viability of the pollen as well as to make hybrids in the variety collection of citrous fruits. Professor Y. Kumagai, of this station, kindly agreed to test the viability of this pollen in 30 per cent. cane sugar solution. His careful observations show conclusively that pollen can be successfully shipped from Florida to Japan and be in viable condition on arrival, four to six weeks after it is gathered.

Grapefruit pollen collected April 6, from one sealed tube (method III.) which was opened May 17, 1915, showed within forty-eight hours a germination of 50 per cent. with the pollen tubes fifteen times the diameter of the pollen grain. Fresh Joppa orange pollen used as a check showed the same germination (50 per cent.) within twenty-four hours, with pollen tubes twenty times the diameter of the pollen grains. Fresh "Ogasawara grapefruit" used as a check showed 80 per cent. germination inside of twenty-four hours, with the pollen tubes twenty times the diameter of the pollen grains. Pollen of Valencia Late oranges used as a check showed a germination of only 20 per cent. within forty-eight hours, and a length of pollen tube of but three to four times the diameter of the pollen grain. Other tubes of grapefruit and tangelo pollen prepared in the same manner (*i. e.*, method III.) showed from 2 to 10 per cent. germination, both with pollen tubes from two to five times the diameter of the pollen grain, while still others gave no results whatever. From observations upon these different lots of pollen it is probable that this may have been due to the pollen having low vitality when gathered. It is obvious, also, that there may be a variation in the viability of pollen of different varieties, or even in pollen from individual flowers.

Grapefruit pollen sent by methods I. and II. showed 7–8 per cent. germination within forty-eight hours, and pollen tubes ten times the diameter of the grain.

Pollen prepared by method IV. was sent late in April, so that no report has as yet been received showing the percentage of germination. However, in a cablegram sent from Tokyo July 8, 1915, Mr. Swingle reports: "Dry pollen successful," indicating that the most promising method for shipment of pollen over long distances is the one last noted, of drying in vacuo over sulfuric acid.

The necessity for stricter quarantine regulations to exclude dangerous diseases and insect pests already operates to prevent the free shipment of many plants from one country to another. As such regulations become more strict, the difficulties of securing plants increase. It is likely, however, that in most cases pollen shipped in vacuum tubes could be

[2] The sources of pollen were Bowen grapefruit and tangelo twigs bearing flowers fully matured but not yet open, gathered at Eustis and San Mateo, Florida. The lower part of each bundle of stems was packed in moist sphagnum, the bundle then wrapped in oiled paper and mailed from Florida to Washington in ordinary mailing cartons.

sent without danger of carrying plant diseases or insect pests.

Maude Kellerman

Bureau of Plant Industry

VALLEY-FILL OF ARID INTERMONT PLAINS

Unfailing tendency too broadly to generalize from a new-found principle is nowhere better shown than in the instance of ascribed origin of the wide intermont plains of the Great Basin in particular and in general of all desert tracts of the globe. So graphic are the descriptions of Basin Range features given by the various members of the famous Fortieth Parallel Survey that even after the elapse of half a century they continue to hold first place with scarcely a question concerning the accuracy of their genetic foundation.

One statement of the late Professor I. C. Russell furnishes the keynote to the whole problem. He speaks of the mountains of Nevada being "buried up to their shoulders in the débris of their own substances." As a corollary he ascribes enormous depths of 2,000 to 3,000 feet to the valley-fill between the various basin ranges. Russell's observations, as well as those of others, are mainly impressions gained on hurried reconnaissances through the region; and the statements made at the time really had little to substantiate them. The conceptions which they represent are in the extreme brilliant and suggestive. For this very reason it is that they go so long unchallenged.

Singularly enough one of Russell's most typical examples of buried mountains, and one oftenest cited as around which the valley-fill is thickest, is a district wherein subsequent investigation conclusively shows the valleys or intermont plains to have rock-floors. In these valleys the strata of the bed-rock are flexed and tilted often to a vertical attitude. The planed surface coincides nearly with the present ground surface. The wash or valley-fill is almost nil. To be sure there may be some instances in which there is a valley filling that has greater or less depth; but in many cases the broad intermont basin has a very pronounced rock-floor and the thickness of regolith or soil mantle is inappreciable.

Other critical data now exist that bear directly upon the extent of the valley-filling. The larger number of deep drill-holes, which have been put down in the desert regions of the west during recent years, furnish some very conclusive evidence touching the points under consideration. Of course well-logs, as a rule, are notoriously fanciful and, without proper checks, can not be implicitly relied upon. Yet many such records are adduced as proving the great depth of valley-fillings.

In a number of cases, which are really test-cases, depths of 2,000 to 3,000 feet are reported as being entirely in wash material. These statements are even presented in scientific literature. In one instance, in which soft Eocene clays and sands were dipping at an angle of 70 degrees, the drill is reported as having penetrated nearly 2,500 feet of wash débris without passing through it. In another case, that of the Santa Cruz Valley, near Tucson, Arizona, the valley-fill was said to be over 2,000 feet thick as shown by the drill; yet the late W J McGee found bed-rock near-by covered only by a few inches of soil.

One of the latest cases of this kind is the interpretation of deep-drill records in the Hueco (Tularosa) bolson in southern New Mexico. Drill-logs of more than 2,000 feet are given as evidence in support of the contention of the great depth of valley-fill. As a matter of fact, and as the records themselves clearly indicate, the beds passed through by the drill are the very red-beds that overlie the Carboniferous limestones of the region, and that one would expect first to encounter a short distance beneath the surface of the desert at those points. Abundant other data from this locality point rather conclusively to the fact that this so-called valley-fill is mainly not wash débris at all but typical soft red-beds. This seems to be another instance of forcing facts to fit theory.

What is still greatly needed in these desert investigations is further critical evidence bearing upon the geological date of the formation of the so-called Basin Range structures.

Until this is forthcoming from those travelers and explorers who are now working in this especial field the Basin Range hypothesis shall have to be considered as holding a place among those hypotheses yet unproven, and as an assumption of very doubtful utility.

CHARLES KEYES

SCIENTIFIC BOOKS

Mechanism, Life and Personality. By J. S. HALDANE. New York, Dutton. 1914. Pp. viii + 139. Price, $1.00.

I

Dr. J. S. Haldane has long been known as a philosophical physiologist. Indeed it is now for more than three decades that he has occasionally relieved the labors of an orthodox and eminent scientific investigator with the pleasures of idealistic metaphysics. At length he has constructed his philosophy of biology into a little book, "Mechanism, Life and Personality," which he offers as a contribution towards "bringing the great biological movement of the nineteenth century into definite relation with the main stream of human thought."

The first half of this book is devoted to an examination of "the hypothesis that living organisms may be regarded as conscious or unconscious physical and chemical mechanisms, and can be satisfactorily investigated from this standpoint." Such is Haldane's statement of the mechanistic theory of life. Many considerations favor such a theory. Chemical analysis reveals no mysterious substances or reactions within the body, general physiology and the study of metabolism reveal no mysterious forms or manifestations of energy, and to all appearances the laws of the conservation of matter and the conservation of energy there hold. Consciousness, to be sure, is a difficulty, but, at any rate, consciousness seems not to interfere with the operation of any law of physics or of chemistry. Moreover, when once we have commenced the analysis of organisms, whether physically or chemically, we find no structure but physical and chemical structure, no activity but physical and chemical activity.

Historically too there is much to justify the mechanistic view, for "the history of physiology displays uninterrupted progress in the successful application of physical and chemical methods to physiological problems."

In the manifold and inconceivably intricate phenomena of organic regulations the mechanist has found serious difficulties. But in the course of time, as the mechanistic nature of nervous control, of the action of hormones, and of similar phenomena were discovered, this difficulty has grown less. Again the very existence of such marvellous physical and chemical structures as living things once seemed mechanistically quite inexplicable. But when Darwin conceived the principle of natural selection this difficulty was removed.

In his zeal to do full justice to the mechanistic theory Haldane even goes so far as to declare that it is possible to imagine how life may have originated. This is perhaps too much, for I suspect that some chemists would still prefer the first chapter of Genesis to the mechanist's guesses upon the subject.

As for the traditional opponents of the mechanistic view, the vitalists and the animists, their theories have ever been sterile. Occasionally encouraged by the collapse of one or another mechanistic theory, their own efforts have nevertheless ended in mere words, for "the apparent autonomous selective action of the organism turns out to be causally dependent in every detail on physical and chemical conditions." Therefore the action of any possible vital principle must be determined by these conditions.

Further the vitalistic theory implies "a definite breach in the fundamental law of the conservation of energy" (according to Driesch not in the first but in the second law of thermodynamics). Moreover the vitalistic agency is itself "entirely unintelligible."

On the other hand, even if the position of the vitalists and animists is entirely unsatisfactory, that does not establish the justice of the mechanistic theory. We must not forget that a living thing never does *seem* to be a mechanism, especially to those who know it well and study it as a whole, that is as a real *organism*. In particular to identify stimulus and response with physical and chemical causation, a belief

which is the very basis of the mechanistic physiology, is "a gigantic leap in the dark." To be sure, the difficulty of making out this causal connection might be due solely to the complexity of the cell, nevertheless "the point must be emphasized that in the case of stimulus and response there is in reality no experimental evidence whatsoever that the process can be understood as one of physical and chemical causation." No real quantitative relation between the supposed cause and the effect can be traced.

No doubt such information as we now possess will continue to increase, biophysics and biochemistry to unfold, but there is no reason to suppose that this kind of information will in the future serve as an explanation of that which in the past it has totally failed to explain.

Historically, in spite of the great services of physics and chemistry to biology, "the mechanistic theory has, on the whole, fared very badly." Cell-growth and cell-nutrition, absorption and secretion, have not been mechanistically explained. Mechanistic theories of respiration and metabolism, of muscular movement and other physiological movements, have also failed. And as the science develops we seem to get further and further away from any prospect of success in such enterprises. In truth ignorance alone could have justified the earlier crude mechanistic theories of the intracellular processes. For "what the mechanistic theory must assume in the case of an organism such as man is a vast assemblage of the most intricate and delicately adjusted cell-mechanisms, each mechanism being so constituted as to keep itself in working order year after year, and in exact coordination with the working of the millions of other cell-mechanisms which make up the whole organism."

But the facts of reproduction and heredity involve still greater difficulties, for we have reason to believe that the whole adult mechanism has come from the nuclear material of the fertilized germ cell. "On the mechanistic theory this nucleus must carry within its substance a mechanism which by reaction with the environment not only produces the millions of complex and delicately balanced mechanisms which constitute the adult organism, but provides for their orderly arrangement into tissues and organs, and for their orderly development in a certain perfectly specific manner." And yet, according to the mechanistic view, this structure of inconceivable complexity is capable of dividing itself to an indefinite extent while retaining its original structure. "The real difficulty for the mechanistic theory is that we are forced, on the one hand, to postulate that the germ-plasm is a mechanism of enormous complexity and definiteness, and, on the other, that this mechanism, in spite of its absolute definiteness and complexity, can divide and combine with other similar mechanisms, and can do so to an absolutely indefinite extent without alteration of its structure. On the one hand we have to postulate absolute definiteness of structure, and on the other absolute indefiniteness."

Hence, says Haldane, the mechanistic theory of heredity is impossible.

The mechanistic theory of heredity must involve in its downfall every other part of biology. "If we can not frame a mechanistic theory of heredity we are equally at a loss in connection with the ordinary phenomena of metabolism, and we have no right to use mechanistic hypotheses in connection with these phenomena." And finally Haldane concludes: "The phenomena of life are of such a nature that no physical or chemical explanation of them is remotely conceivable."

This conclusion leads to the second half of the book which begins with a philosophical discussion of the nature of reality. Out of this is developed the Hegelian conclusion "that a special category or categories ought to be added (to those of the physical sciences) for organic life, as the idea of life is one of the fundamental ideas. There is no reason why a category or general conception of life should not be just as much constitutive of our experience as the category of substance. Here, therefore, we have a possible way out of our difficulties with the mechanistic theory of life. In trying to reduce life to physical and chemical mechanism we are perhaps in some way con-

fusing two different categories. Kant's general philosophical conclusions have in any case thrown a quite new light on our conceptions of the physical world, and have taught us that the validity of these conceptions is of a very different nature from what was previously believed. It may be that just as we can not base physics on the purely mathematical conceptions of extension, so we can not base biology on the purely physical conceptions of matter and energy."

The whole living structure is organized, every part is definitely related to every other part. This is also true of its activity or metabolism. Thus it has come about that "in dealing with life we not only use a whole series of special terms, but these terms appear to belong to a specific general conception which is never made use of in the physical sciences." "The fundamental mistake of the mechanistic physiologists of the middle of last century was that they completely failed to realize this. Such processes as secretion, absorption, growth, nervous excitation, muscular contraction, were treated as if each was an isolable physical or chemical process, instead of being what it is, one side of a many-sided metabolic activity, of which the different sides are indissolubly associated."

"Our ordinary language as applied to life corresponds to these characteristics. We naturally speak of a living organism as an autonomous active whole, and think of it as such. The idea of its being a mechanism made up of separable parts, and actuated by external causes, is wholly unnatural to us, and becomes more and more unnatural the more we know about organisms."

"The concept we are using is radically different from any physical concept: for in conceiving what is living we do not separate between matter or structure and its activity."

"If we assume that the conception of the living organism is the fundamental conception of biology, it is clear that the aim of biology differs entirely from what it would be if the mechanistic theory were accepted. All attempts to trace the ultimate mechanism of life must be given up as meaningless."

On the contrary, the goal of biology must be the description of the organism as an organic unit. This proposition is illustrated by a discussion of the physiology of respiration, and the conclusion is reached that "the idea which gives unity and coherence to the whole of the physiology of respiration is that of the organic determination of the phenomena." And in general by means of this conception "we introduce order and intelligibility into biology, whereas there is no such order or intelligibility if the mechanistic theory of life be adopted."

Finally it is necessary to take account of one other characteristic of the higher organisms, of consciousness. Haldane's conclusion upon this point is as follows:

"We must, it seems to me, draw a sharp and clear distinction between biology, which deals simply with organic life, and psychology, which deals with conscious life or personality. This distinction is similar in general nature to that which I have already endeavored to draw between physics and biology. Just as biology is a more concrete science, nearer to reality than physics and chemistry, so psychology is a more concrete science than biology. We can abstract from the psychological aspect of a man or animal, and regard him only from the biological aspect. This is, in fact, what we do in physiology. In regard to most of the details of bodily activity there is little need for deliberate abstraction, since the psychological element lies only in the background. But when we come to deal with the bodily parts more immediately concerned in perception and voluntary response the case is very different. Perception, voluntary response, and conscious activity of every kind belong to personality, and therefore can not as such be dealt with scientifically from the merely biological or physiological standpoint. We might as well attempt to establish physics on a basis which totally disregarded the facts on which the conceptions of mass and energy are based, as to establish psychology on a merely physiological basis."

"Physiology deals, and ought to deal, with living organisms just in so far as the observa-

tions relating to them can be ordered in terms of the conception of a living organism. Where, and in so far as, the conception of a mere organism fails, as in the facts relating to conscious activity, we must have recourse to another conception, that of personality."

"It is evident that in applying the conception of personality to man or animal we leave out of account the details of organic activity. But the details are there, and the only account we are in a position to give of them is in terms of the lower or less concrete conception of mere organic activity. If we go still further into detail we are reduced to a still more abstract account in terms of physics and chemistry. Hence although in giving an account of perception and volition as a whole we make use of the conception of personality, and can not otherwise state the facts, there is abundant room left for a physiological account of the sense organs, nervous system, muscular activity, etc., provided that we recognize that such an account always deals abstractly with the phenomena, for the sufficient reason that a fuller and more concrete account can not at present be given. In the same way we treat the action of the muscles on the limbs, or of the limbs on the environment, or of the environment on the sensory organs, from the merely physical standpoint. This is an abstract method of treatment, as we have already seen; but it is to some extent the only method available. Provided we do not make the mistake of confusing the physical account of the world with reality, we are perfectly justified in making all the use we can of this physical account."

II

It is no light task for a man of science to form a critical judgment of this book, for I believe that its weakness is on the philosophical side. Certain it is that there is great justice in Haldane's strictures upon the supporters of the mechanistic view. Not only have mechanistic theories of physiological actions been almost uniformly of a childish crudeness, falling far beneath the complexity of the facts, but the mechanists have indeed, in the past, failed to recognize the significance of organization. And for my part I think that Haldane is quite right in establishing organization as something of a different order from mechanism, and elevating it into a category. The mechanists, having been obliged to isolate the phenomena, because such is the necessary condition for the physical and chemical study of them, have forgotten what they have done, and have not thought about organization at all.

It is, however, one thing to recognize the weakness of particular mechanistic theories of the past, or the difficulty, or even the inconceivability, of a mechanistic theory of heredity, and it is quite another thing to conclude that such a theory is impossible, especially in the face of Morgan's recent researches. The explanation of that which Darwin explained was once inconceivable. And one wonders what Galileo or Newton would have done with an electric battery if he had been asked to explain it as a mechanism. It is quite true that we possess no clue to the mechanism of the cell in general as distinguished from important particulars; it is perhaps probable that the task is too great for the human mind, but it is not possible by such a discussion as Haldane has given in the first part of his book to prove its ideal impossibility. The cell is a contrivance unlike anything which we understand, but so for Newton would have been an electric battery, and without further information he simply could not have begun to think about it.

When we turn to Haldane's philosophical objections to the mechanistic standpoint we encounter, as I believe, grave inconsistencies in his argument. True it is that "we can not base physics" *exclusively* "on the purely mathematical conceptions of extension," but physics would be in a very bad way indeed in an ungeometrical universe, or if it were obliged to get on without geometry. Geometry has no need of physics, it is true, though Archimedes showed how to solve geometrical problems by means of mechanics, but physics has imperative need of geometry. Geometry knows neither mass nor energy, but physics knows and uses points and lines.

In exactly like manner physical science has no need of the idea of organization, and knows it not. But biology, with organization as its central fact, both knows and uses physics and chemistry. Logically the less abstract encloses and includes the more abstract. The more abstract meantime preserves its full validity in the domain of the less abstract, just as, for example, the laws of number and extension hold in the physical sciences. So generally true is this that there is hardly any need of seeking illustrations. Haldane's own studies are studies of the organization of the physical and chemical processes of respiration. There can be no doubt that the idea of organization is what informs and interprets such investigations, and that it is an indispensable aid in their pursuit. Quite recently, for example, it has successfully guided Cannon in his researches on the physiology of fear and rage.

There is even a possibility, we may note in passing, in a certain restricted field, of pursuing the study of organization without regard to physics and chemistry. But that field is quite different from physiology, it is the field of animal behavior. In physiology there is no such possibility.

The truth seems to be that the relation of an organism to cellular mechanisms is not unlike the relation of a symphony to the sound waves which bear it to the ear. It is absurd to regard the symphony as merely the sum of the waves of sound, just as it is absurd to regard the organism as merely the sum of the biophysical and biochemical phenomena. But it is quite as absurd to deny that the sound waves are in a very real sense (even if they are not in "reality") the component parts of the symphony. They are, moreover, the only component parts which at present can be profitably investigated, as the difference between the substantial character of musical science, and our vague ideas about the individuality of thematic material well shows. If we turn to Haldane's own experimental researches we shall find that that is precisely his own standpoint as a practical physiologist; he analyzes the phenomena of organization into their component physical and chemical parts. If then "all attempts to trace the ultimate mechanism of life must be given up as meaningless," that can be only because there are only mechanisms, no *ultimate* mechanism of life. And for my own part I am obliged to say regarding his statement: "The phenomena of life are of such a nature that no physical or chemical explanation of them is remotely conceivable," that it is true only in a sense quite different from its apparent meaning, and is of no *scientific* interest.

A sound understanding of the relation between organic unity and physical phenomena involves no hypothesis regarding the nature of the external world or of reality. It may in the past have had a tendency to involve false ideas upon that subject in much the same way that the practical life of affairs does. But in physiology as in physics there is, I believe, no need to worry about the nature of reality. If the physiologist has foolish or mistaken notions on that subject, it is his private concern. Such ideas may affect his attitude toward the world; they do not affect his attitude toward his science. For in that he is dealing not with "reality," but with "truth," and the "truth" of his physical and chemical discoveries, when properly attested, is of exactly the same order as the truth of a proposition in geometry or of a law of harmony, which is enough.

Another characteristic of Haldane's thought is that he seems to attribute more value to concrete than to abstract scientific knowledge. From the purely metaphysical point of view such an attitude is quite intelligible. But scientifically it appears to be a matter of taste. The mathematical law will always have its devotees, and it will be many a day before such men will see in the progress of psychology anything to equal Newton's "Principia" in interest, in value or in greatness. And yet I am persuaded that such men will heartily recognize the concept of organization for what it is. They must then admit the need of Haldane's most interesting and timely discussion of a very difficult subject, and repay him with their gratitude.

L. J. HENDERSON

HARVARD UNIVERSITY

The Electron Theory of Matter. By O. W. RICHARDSON, Wheatstone Professor of Physics at Kings College, London. Pp. vi + 612. Cambridge Univ. Press. 1914.

THIS is in many ways a very remarkable book. Its scope is broader than that of any book on Electron Theory which has yet appeared, and it has the unique merit of not following even remotely the outline of J. J. Thomson's epoch-making work in this field. The author himself has exhibited within the past fifteen years, an unusual combination of theoretical and experimental fertility, and the present volume represents his digest, from the beginning, of the whole field of electromagnetic theory from both the theoretical and the experimental side. It exhibits profundity of scholarship, breadth of knowledge, enormous industry and a commendable fairness and reasonableness of temper.

The first 216 pages contain mainly the author's own treatment of nearly all of the most important of the classical theorems of electromagnetism such as the various potential theorems and those growing out of the Maxwell equations. From this point on is found a very exhaustive and original treatment of practically all of the newer developments of physics the scope of which can best be seen from the chapter headings. There are eighty pages on the electrodynamics of a moving charge, including a full discussion of the Abraham and Lorenz theorems; sixty pages on relativity; thirty-five on radiation and temperature with Wien's and Planck's contributions; forty on the theory of magnetism with a full review of Weiss' work; seventy-five pages on the electron theory of metallic conduction, thermo electromotive force, and thermoionics; thirty-five pages on "Types of Radiation" corpuscular and ethereal, including recent X-ray theory; thirty-five pages on spectroscopic phenomena; forty on the structure of the atom with Thomson rather overdone and Nicholson and Bohr somewhat slighted; and sixteen on gravitation.

Altogether it is a book of large and permanent value and another testimony to the breadth and fecundity of British science.

R. A. MILLIKAN

RYERSON PHYSICAL LABORATORY,
UNIVERSITY OF CHICAGO

SPECIAL ARTICLES

A SYSTEM OF RECORDING TYPES OF MATING IN EXPERIMENTAL BREEDING OPERATIONS[1]

ALL Mendelian experimentation with bisexual forms implies a system of mating which in practical work is called line breeding. One starts any Mendelian experiment with two kinds of organisms which are crossed with each other to produce the F_1 generation. Then the F_1 individuals are either mated *inter se* or back-crossed to the parent forms. The F_2 individuals may be mated in a variety of ways *inter se* and with the parents or grandparents.

Many of those engaged in Mendelian work must have experienced the same difficulty that the writer has in recording experimental results, namely, that of expressing adequately and completely, and at the same time briefly and simply the general nature or type of the

Diagram I

P generation	BPR ♂	× Houdan ♀
F_1 generation	F_1 ♂	× F_1 ♀ from reciprocal cross
F_2 generation	F_2 ♂	× BPR ♀
F_3 generation		F_3 ♂ *M*

Diagram II

P generation	Houdan ♂	× BPR ♀
F_1 generation	F_1 ♂	× Houdan ♀
F_2 generation	F_2 ♂	× F_2 ♀ from reciprocal cross
F_3 generation		F_3 ♀ *N*

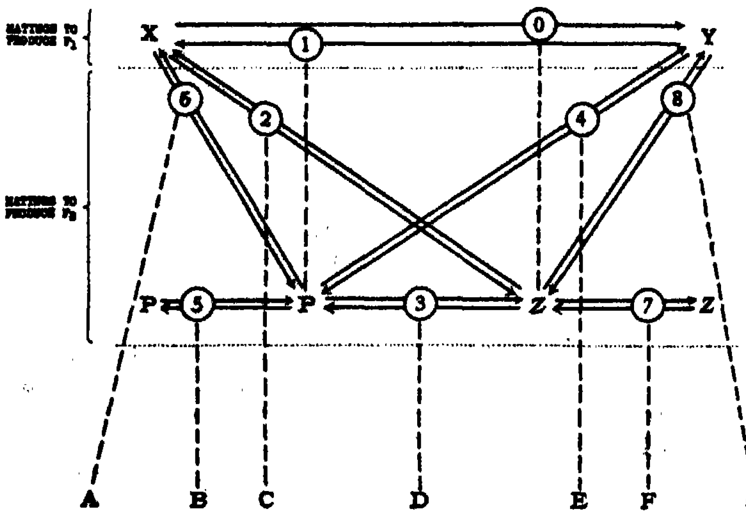
[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 88.

pedigree by which particular individuals in the F_2 and F_3 generations are descended. To illustrate the meaning here let us consider the two individual fowls M and N produced as indicated in pedigree diagrams I. and II.

To describe in words how M or N was bred is a tedious piece of business. They are both F_3 individuals from a cross of the same two breeds of poultry, Barred Plymouth Rock and Houdan. Yet their breeding is very different. It is of the utmost importance in planning breeding experiments, especially when one comes to the matings of F_2 individuals, to have a clear picture in one's mind of the breeding of each individual back to the original cross. The writer has wrestled for some time with this problem and tried out various schemes, such as the use of initial letters, figures for years, etc. None of these has proved satisfactory in practise. It finally seemed clear that the only entirely satisfactory solution (to the writer at least) would be one which was perfectly general. Such a general solution involves two things: first, a complete conspectus of all possible types of mating of the individuals of the P, F_1 and F_2 generations *inter se*, both within and outside their own generations, and second, a simple, pre-

TABLE I

Matings to Produce F_3



F_2 Individuals Mated	Number of Mating	F_2 Individuals Mated	Number of Mating	F_2 Individuals Mated	Number of Mating	F_2 Individuals Mated	Number of Mating
$A \times X$	10	$B \times Z$	46	$C \times F$	51	$E \times E$	19
$A \times Y$	12	$B \times B$	13	$C \times G$	53	$E \times F$	45
$A \times P$	40	$B \times C$	37	$D \times X$	22	$E \times G$	47
$A \times Z$	42	$B \times D$	29	$D \times Y$	24	$F \times X$	30
$A \times A$	11	$B \times E$	55	$D \times P$	52	$F \times Y$	32
$A \times B$	33	$B \times F$	57	$D \times Z$	54	$F \times P$	60
$A \times C$	25	$B \times G$	59	$D \times D$	17	$F \times Z$	62
$A \times D$	35	$C \times X$	18	$D \times E$	43	$F \times F$	21
$A \times E$	61	$C \times Y$	20	$D \times F$	31	$F \times G$	49
$A \times F$	63	$C \times P$	48	$D \times G$	27	$G \times X$	34
$A \times G$	65	$C \times Z$	50	$E \times X$	26	$G \times Y$	36
$B \times X$	14	$C \times C$	15	$E \times Y$	28	$G \times P$	64
$B \times Y$	16	$C \times D$	39	$E \times P$	56	$G \times Z$	66
$B \times P$	44	$C \times E$	41	$E \times Z$	58	$G \times G$	23

ferably numerical, designation of each one of these possible types, each such designation to be of course unique and permanent.

Table I. gives such a general solution of the problem of simply designating pedigree types, through the matings of F_3 to produce F_4. Beyond that it is not practical to go. A word should be said in explanation of the table. Letters denote *individuals* or groups of individuals which are brothers and sisters. Solid lines, with circles in their course, connecting letters, denote *matings* of the kinds of individuals indicated by the connected letters. Dotted lines lead from the mating to the kind of individual produced. Arrow heads indicate the direction of the mating, the arrow being supposed always to pass from the male to the female. Separate numbers are not given to reciprocal matings *after* the matings of the P generation to produce F_1. To designate separately reciprocal matings after that point would greatly complicate the system without any significant gain from a practical point of view. In the later generations, reciprocals may be indicated if desired, by affixing a sub-figure 1 to the designation of the mating.

The numbers within the circles are the designations (or names) of the matings, and from the very nature of the case, these numbers designate not alone the particular mating but also, in F_1 and later generations, the nature of the pedigree of each of the individuals entering that mating. This will be clear as we proceed.

This table is to be read in the following manner: Individual *X*♂ is mated with *Y*♀ to produce F_1 individuals *Z*, and this mating is designated 0. Individual *Y*♂ is mated with *X*♀ and produces F_1 individual *P*, and the mating is 1. The F_1 individuals, mated in all possible ways *inter se* and with the parents *X* and *Y*, as indicated in matings designated 2 to 8 inclusive, produce seven kinds[2] of F_2 individuals, *A* to *G*. These seven sorts of F_2 individuals bred in all possible ways *inter se* and with their parents and grandparents produce 56 sorts of F_3 individuals, as indicated in the lower half of Table I. As already noted, separate account of reciprocals is not taken.

[2] "Kinds" referring here only to the manner in which the individuals have been bred.

The use of the table may be indicated by some examples. Suppose one wishes to mate in an experiment the two birds called *M* and *N* in an earlier paragraph of this paper. He will wish to indicate in some way in his notes the previous breeding history of each of these birds. If he does this verbally—and hitherto this appears to have been the only way of reaching such end—he must say of individual *N*, for example, something like the following: "This F_3 bird was produced by the mating of an F_2 male with an F_1 female produced by mating a Barred Plymouth Rock male with a Houdan female. The F_2 male was himself produced by the mating of an F_1 male, out of the cross Houdan male by Barred Rock female, on a pure Houdan female." Quite apart from the amount of space involved in such a setting forth of the facts, it is very difficult to form quickly a clear mental picture of the bird's pedigree from this tedious verbal exposition. Suppose we are using the system of pedigree designation discussed in this paper we could then cover all the facts set forth above about bird *N* by merely writing in our notes

"*Bird N (58) BPR-Houdan series,*"

and to describe completely the mating of *M* with *N* we have merely to write

"*F_2♂M (22) × F_3♀N (58) BPR-Houdan series.*"

The figure 58 in the case of *N* means that she was produced from a mating of the type indicated in the table as *E* × *Z*, and the des-

DIAGRAM II

Houdan ♂ × *BPR* ♀

(*Y*) (1) (*X*)

↓

F_1♂ × Houdan ♀

(*P*) (4) (*Y*)

↓

F_2♂ × F_1♀ from reciprocal cross

(*E*) (58) (*Z*)

↓

N

ignation of such a mating is 58. This will be made clear by repeating the pedigree diagram of bird *N*, *Diagram II.*, and adding to it the proper letters and mating designations from Table I.

The simplicity of the scheme is obvious. No argument appears necessary as to its usefulness in experimental breeding operations. The writer has found it extremely helpful and clarifying.

A word should be added in regard to the system by which the numbers have been assigned to the matings. It might at first sight appear as though the arrangement were an entirely haphazard one. It is not. On the contrary the numbers will be found to conform to the following general principles, which seem likely to be of aid in practical work, as tending to make it easy to recall from a number just what its particular pedigree looks like.

1. All even numbers refer to back-cross matings.

2. All odd numbers refer to co-fraternal or intra-generation matings (not back-crosses).

3. Matings below 2 are of parental generation individuals: between 2 and 8 inclusive are of F_1 individuals; matings over 10 are of F_2 individuals.

4. Even numbers from 10 to 36 inclusive designate back-crosses of F_2 individuals with their *grandparents*, or individuals of the grandparental generation.

5. Even numbers from 40 up designate back-crosses of F_2 individuals on F_1 individuals.

6. In the case of the odd numbers from 11 up it is, *in a general way*, true that the smaller the designating number of a mating the more closely related to each other are the two individuals entering that mating likely to be. This principle of assigning the numbers could not be so precisely followed as the preceding five, but still is perhaps worth a little.

In using this system in one's notes or writing it is of course essential to have the basic table always at hand. If the plan should appeal to any number of experimental workers it would be a simple matter to have copies of Table I. printed on heavy cardboard to be used in breeding houses and pens, in the field and at the desk.

Raymond Pearl

Agricultural Experiment Station,
Orono, Me.

THE CHEMICAL COMPOSITION OF BORNITE

Since the analyses of crystallized material from Cornwall by Plattner,[1] bornite has generally been considered to be a cuprous sulfoferrite, $Cu_3FeS_3(3Cu_2S\cdot Fe_2S_3)$. In 1903 Harrington[2] made a critical study of the published analyses, added several new analyses, and concluded that the chemical formula of bornite is $Cu_5FeS_4(5Cu_2S\cdot Fe_2S_3)$. Recently Kraus and Goldsberry[3] made an analysis of crystallized bornite from Bristol, Conn., which gave the formula $Cu_{12}Fe_2S_9(6Cu_2S\cdot Fe_2S_3)$, and also confirmed Harrington's formula Cu_5FeS_4, of crystallized bornite from the same locality. They conclude that bornite is of variable chemical composition, and in order to explain the facts they assume a morphotropic series of minerals ranging from chalcopyrite, $CuFeS_2$, through barnhardtite, $Cu_4Fe_2S_5$, and various bornites $Cu_6Fe_2S_6$, $Cu_8Fe_2S_7$, $Cu_{10}Fe_2S_8$, $Cu_{12}Fe_2S_9$, up to $Cu_{76}Fe_2S_{41}$, finally ending with chalcocite Cu_2S, each member of the series differing from the one below it by the addition of one molecule of Cu_2S.

As a metallographic examination of the two analyzed bornites showed no foreign admixture, the work of Kraus and Goldsberry furnishes, for the first time, proof that bornite is variable in composition. It is believed, however, that there is a more rational explanation of the variability in composition of bornite than the one advanced by Kraus and Goldsberry.

The recorded analyses of bornite show a copper content varying from 77 to 55 per cent., and an iron content varying from 18 to 6 per cent. In Fig. 1 I have plotted on the triangular coordinate diagram of J. Willard Gibbs the available bornite analyses (59 in number) given in Hintze's "Handbuch" and in the

[1] *Pogg. Ann.*, 47, 351, 1839.

[2] *Amer. Jour. Sci.*, 16, 151, 1903.

[3] *Amer. Jour. Sci.*, 37, 539, 1914.

articles of Harrington and Kraus and Goldsberry. (For analyses with more than two or three per cent. of gangue the percentages have been recalculated.) The small triangle furnishes a key to the larger diagram which represents one sixth the area enlarged tenfold. The diagonal line crossing the diagram is the locus of analyses of minerals in Kraus and Goldsberry's series, $Cu_xFe_2S_{\frac{x}{2}+3}$. This ranges from $CuFeS_2$ on the left to Cu_2S on the right. Most of the analyses are ranged along this line. Those much above the line are probably that very few of the massive bornites are entirely free from other minerals, but chalcopyrite and chalcocite, the two most common impurities in bornite, tend to neutralize the effect of each other for

$$CuFeS_2 + Cu_2S = Cu_3FeS_3$$

and

$$CuFeS_2 + 2Cu_2S = Cu_5FeS_4.$$

Because of this, and because the *impurities* are often trifling in amount, the analyses may be used with caution.

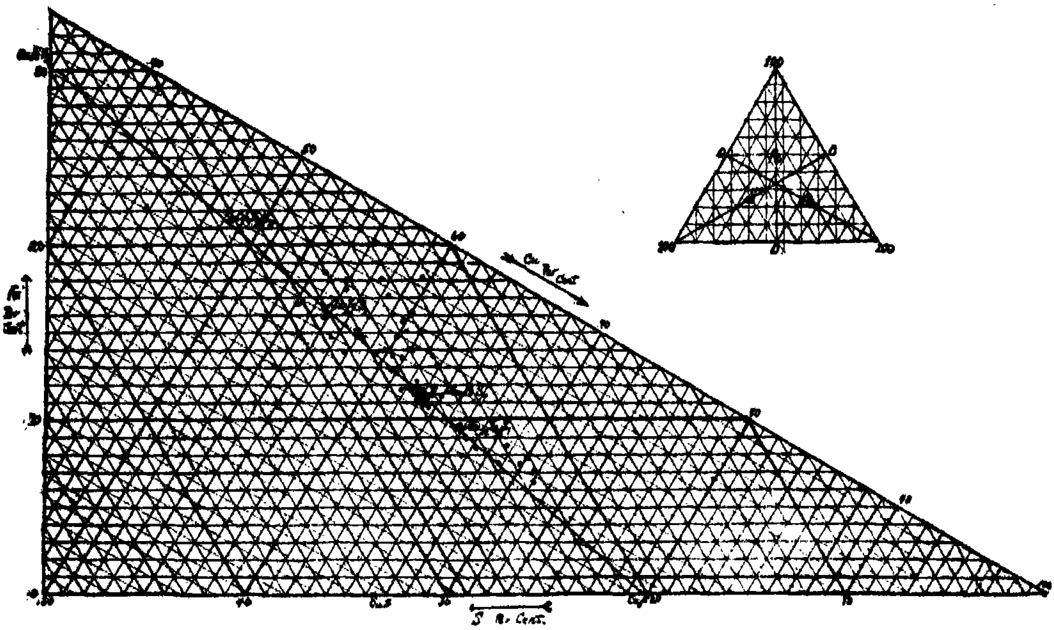


Fig. 1.

due to errors in the analyses or to the presence of oxidation products.

The only clustering of points in the diagram is around Cu_5FeS_4. Some may interpret this as evidence that bornite has the formula Cu_5FeS_4, but on the solid solution hypothesis advanced later on it may simply represent the average solubility. Most of these analyses were made upon massive material and as the study of polished sections proves, apparently pure, massive bornite usually contains small amounts of chalcopyrite, chalcocite or covellite, and occasionally other minerals. It is safe to say

The lower limit of bornite seems to be represented by Cu_5FeS_4 with iron content of 16.36 per cent.; the Cornish crystals approach this formula and an artificial bornite made by Böcking[4] is very close to the theoretical for Cu_5FeS_4. Only seven analyses out of the fifty-nine show more than 16.3 per cent. iron. A slight admixture of chalcopyrite (Fe = 30.5 per cent.) will easily account for the excess iron. The lowest iron content on record is 6.4 per cent. The low iron content of some of the

[4] Hintze, "Handbuch der Mineralogie," Vol. I., p. 914, 1901.

bornites is doubtless due to admixed chalcocite just as the iron content of chalcocite is usually due to admixed bornite.

There are four possible explanations of the variability in chemical composition of bornite, viz: (1) Mechanical mixture, (2) isomorphous mixture, (3) morphotropic series (Kraus and Goldsberry), (4) solid solution.

1. While it is certain that mechanical mixtures explain part of the variability, some other factor is involved, as we know from the analytical results of Kraus and Goldsberry.

2. The isomorphism of bornite and chalcocite does not seem at all probable for there is not much similarity in chemical composition; moreover, one is isometric, the other orthorhombic.

3. The term morphotropy was introduced by Groth[5] to indicate the change in crystalline form brought about by substituting in a chemical compound an atom or group of atoms for a similar atom or group. The best examples of morphotropy are furnished by organic compounds. The only clear case of morphotropy (in its original restricted sense as distinct from isomorphism) among minerals is the humite group. Kraus and Goldsberry contend that there are various bornites each with a definite formula. As far as known bornite is isometric and, if so, it is difficult to conceive of any crystallographic change that can be brought about by the addition of the Cu_2S molecule. Complex formulæ like $Cu_{34}Fe_2S_{20}$, $Cu_{40}Fe_2S_{23}$ and $Cu_{76}Fe_2S_{41}$ are very improbable and it is probably a coincidence that the percentage compositions of the crystallized bornite from Bristol are so close to the theoretical values of $Cu_{10}Fe_2S_8$ and $Cu_{12}Fe_2S_9$.

4. In order to explain the variable chemical composition of bornite, the hypothesis of solid solution is advanced by the writer. As the lower limit of bornite seems to be Cu_3FeS_3, the variation in composition can be explained by assuming that *bornite is a solid solution of Cu_2S in Cu_3FeS_3* which may be indicated thus: $Cu_3FeS_3(Cu_2S)_x$. This makes an indefinite upper limit for the copper content. There is proof that it is as high as $Cu_{12}Fe_2S_9$, and it probably goes still higher. The composition of bornites listed on page 547 of Kraus and Goldsberry's paper is as easily explained by the solid solution hypothesis as by any other and from a chemical standpoint it seems far more reasonable. The solid solution hypothesis also helps to explain the fact that chalcocite rarely occurs as an original hypogene[6] mineral for it seems probable that cuprous sulfoferrite (Cu_3FeS_3) can take up or dissolve appreciable amounts of cuprous sulfid, and hence chalcocite is not formed until a later stage when a change of conditions is brought about by decrease of temperature. It may also explain the readiness with which bornite alters to chalcocite. There is very little microscopic evidence to show that bornite and chalcocite are formed simultaneously except perhaps locally in the so-called intergrowths. The origin of these graphic intergrowths will be discussed by the writer in a forthcoming paper.

[5] *Pogg. Ann.*, 141, 31, 1870.

The long series of sulfo-salt minerals given by Kraus and Goldsberry fails to convince me of the general application of morphotropy in this group. Minerals represented by some of the formulæ in the series are doubtless examples of solid solutions, and some of these minerals are undoubtedly mechanical mixtures. Imagine what a bewildering lot of transparent minerals might have been recognized if mineralogists had had no microscopic check on their chemical work. A revision of the opaque sulfo-salt minerals seems necessary. In such work the metallographic microscope will be of great assistance.

AUSTIN F. ROGERS
STANFORD UNIVERSITY, CALIF.

STUDIES IN THE MEASUREMENT OF THE ELECTRICAL CONDUCTIVITY OF SOLUTIONS[1]

IT is a striking fact that very few investigators of conductivity have striven to make the measurements with an accuracy approach-

[1] This work was made possible by a grant from the Carnegie Institution of Washington to Professor S. F. Acree. New Orleans meeting of the American Chemical Society, April, 1915.

[6] This useful term is used by Ransome for minerals or ores formed by ascending solutions.

ing 0.01 per cent., and the writer has, with suggestions from Professor S. F. Acree, attempted to improve upon the technique employed by studying the conductivity cells, the baths, temperature regulation, the bridge and resistances, the methods of making and handling the solutions, and the so-called electrode and polarization phenomena. This improvement is now necessary in order to allow the writer to use the conductivity method for the determination of ionizations and reaction velocities in dilute solutions. He is indebted to Dr. Curtis[2] and Dr. Wenner, of the National Bureau of Standards, for much valuable advice, and the fine work of Washburn[3] and Bell shows what great improvements can be made in this line.

The writer has used the excellent equipment of the Bureau of Standards and some fine apparatus loaned us by Leeds and Northrup in making a fundamental study of a large number of factors, some of which have already been investigated in conductivity work by physical chemists. As a result of this work he has already greatly improved the methods and has studied: (1) the current from (*a*) induction coils, (*b*) a Holzer-Cabot wireless generator, (*c*) a General Electric Company large generator, (*d*) a Siemans-Halske generator for conductivity work, and (*e*) a Vreeland oscillator furnished by Leeds, Northrup & Co., which we have found to be the best source of current yet tried, as it gives a pure sine wave of uniform frequency which can be varied very widely; (2) the voltage, which when varied from 0.25 to 8 volts, has shown no influence on the resistance of the solutions measured so far *in very clean cells*, but is very important in cells not entirely clean; (3) the size and shape of the electrodes, which have a very large influence on the change of resistance and capacity of the cell with change in frequency; (4) the material used in making the electrodes (Pt, Au, Ag, Cu, Zn, etc.), which is very important; (5) the state of aggregation of the surface of the electrodes, as in plain, gray and platinized electrodes, which has a very great influence on the capacity of the cell and change of resistance with change in frequency; (6) the frequency of the alternating current, which when varied may change the resistance of some solutions in some cells as much as 3 per cent.; (7) the high capacity of the cell as a condenser, which is very important in decreasing the change of resistance with change in frequency and in obtaining a perfect minimum in the telephone; (8) the valence and velocities of the different ions; (9) the influence of the concentration and the character of the electrolyte and the solvent on the change of resistance with change in frequency; (10) the proper use of a condenser or inductance in balancing the capacity of the cell, and its influence on the resistance and minimum in the telephone; (11) the construction of the cell in such a way that no errors from evaporation and concentration can be produced; (12) the use of a tuned telephone attached to a stethoscope or of double wireless telephones; (13) the construction of a Wheatstone bridge with Curtis resistances free from inductance and capacity, kept automatically at constant temperature, and arranged so that every resistance can be checked against the others and against standard enclosed resistance; (14) the development of especially good constant temperature baths for such work; (15) the use of weight methods and special apparatus for making, keeping and transferring solutions; (16) a number of points connected with the proper use of all of the apparatus, especially the electrical equipment, to prevent errors arising from induction, capacity, skin effects, electrical leaks and other factors; (17) our criterion of excellent cells, namely that each one must be independent of the above sources of error and give readings constant to within 0.01 per cent., and especially that *whatever the solution used, the ratios of the resistances in any two such cells must be constant to within 0.01 per cent.* Only in this way can we be certain that the electrode effects have been practically eliminated and that we are measuring the true electrical resistance of the solution with great

[2] Curtis & Grover, Bureau of Standards Bulletin, Vol. 8, No. 3.

[3] *Jour. Am. Chem. Soc.*, 35, 177, 1913.

accuracy. By studying the electrode phenomena and other sources of error and correcting them we have now reached a precision of 0.001 per cent. and an accuracy of about 0.01 per cent. The details of all this work will appear shortly in another article.[4]

W. A. TAYLOR

DEPARTMENT OF CHEMISTRY OF FOREST PRODUCTS,
UNIVERSITY OF WISCONSIN

PROCEEDINGS OF THE AMERICAN PHYSICAL SOCIETY

MINUTES OF THE SAN FRANCISCO MEETING

THE seventy-eighth meeting of the American Physical Society was held at San Francisco, August 2 to 7, 1915. It was a joint meeting with Section B of the American Association for the Advancement of Science. The programs of the meeting on Tuesday, Wednesday and Thursday were in charge of the committee of the Pacific Coast division of the American Association for the Advancement of Science, of which Professor Fernando Sanford was chairman, and those of Friday were in charge of the Physical Society, President Merritt presiding. The meeting on Wednesday was held at Stanford University, Palo Alto. All other sessions for the reading of physics papers were held at the physical laboratory of the University of California, Berkeley. General sessions of the American Association for the Advancement of Science were held in San Francisco.

The following papers were presented:

Tuesday Afternoon—Spectroscopy

(1) "A Summary of the Leading Features of Electric Furnace Spectra"; (2) "The Spectrum of the 'Tube-arc' and a Comparison with Line Dissymmetries in Spark Spectra," by Arthur S. King.

"Review of Laboratory Studies of the Zeeman Effect, at Mount Wilson Solar Observatory," by Harold D. Babcock.

"Pole Effect in the Arc and Its Relation to Other Investigations," by Charles E. St. John and Harold D. Babcock.

"The Efficiency of Astronomical Spectrographs," by Joseph Moore.

Wednesday Afternoon (at Stanford University)

"Discussion and Demonstrations of High Potential Electric Currents," by Harris J. Ryan.

[4] See Taylor's address before the Physical Chemical Section of the American Chemical Society, New Orleans, April 1-3, 1915, and *Physical Review*, 6, 61 (1915).

Thursday Forenoon and Afternoon—Physics of the Air

"The Thunderstorm," by W. J. Humphreys.

"New Concepts in Aërology," by A. G. McAdie.

"The Application of Physical Principles to Problems Suggested by Oceanic Circulation and Temperatures," by George F. McEwen.

"Radiation and the Atmosphere," by C. G. Abbot.

"Solar Radiation and Terrestrial Magnetism," by L. A. Bauer.

"On the Origin and Maintenance of the Earth's Negative Charge," by W. F. G. Swann.

"The Natural Charges of the Elements," by Fernando Sanford.

Friday Forenoon and Afternoon

"Thermo-electric Properties of Alloys of Bismuth and Tin," by A. E. Caswell.

"On the Free Vibrations of a Lecher System IV." (By title.) By F. C. Blake and Charles Sheard.

"Resistance of a Spark Gap," by W. P. Boynton.

"On the Resolving Power of Photographic Plates," by Orin Tugman.

"Sensitive Moving-coil Galvanometers," by Frank Wenner and Ernest Weibel.

"An Experimental Verification of the Law of Variation of Mass with Velocity for Cathode Rays," by Lloyd T. Jones.

"The Oxide Resistance Thermometer," by S. L. Brown.

"New Form of Radiation Pyrometer," by S. L. Brown.

"Electromotive Forces in Isothermal Metallic Circuits," by Gilbert N. Lewis.

"A New Method of Determining the Amplitude of Sound Vibrations in Air with Demonstration," by E. P. Lewis.

"An Application of the Koch Registering Microphotometer for Measuring the Sharpness of Photographic Images," by Orin Tugman.

"Photographic Study of the Tone of the Violin," by D. C. Miller.

"The Variation of the Photoelectric Current with the Angle of Emission," by Willard Gardner.

"A Quantitative Determination of the Earth's Penetrating Radiation," by C. H. Kunsman.

"Ultra-violet Absorption Spectra," by R. L. Sebastian.

"The Ultra-violet Spectra of Krypton and Xenon," by E. P. Lewis.

"The Law of Cohesion in Mercury," by P. A. Ross.

"Note on the Theory of Ionization by Collision," by W. P. Roop.

"Heat Losses from Incandescent Filaments in Air," by L. W. Hartman.

"Magnetic Field Produced by Rotating Solid Conductors in a Magnetic Field." (Read by abstract.) By S. R. Williams.

Many physicists accepted the invitation to attend a joint meeting of Section A, the American Mathematical Society and the American Astronomical Society Tuesday forenoon to hear addresses on "The Human Significance of Mathematics," by C. J. Keyser, Columbia University, and "The Work of a Modern Observatory," by G. E. Hale, Mt. Wilson Observatory, Pasadena. Professor Hale's address was illustrated by interesting experiments on vortex motion.

Several instructive demonstrations were arranged by Professor E. P. Lewis, some of them at the request of Dr. Hale, where they could conveniently be examined between sessions. Among them were: Professor Stebbins's photoelectric cell for stellar photometry; the Zeeman effect with echelon grating, Fabry and Perot étalon and Lummer and Gehrecke plate; mercury fringes with Fabry and Perot interferometer; the amplitude of sound vibrations made visible by the forced vibrations of lycopodium particles.

Tuesday noon visiting physicists, astronomers and mathematicians and accompanying ladies were the guests of Professors E. P. Lewis, Haskell and Leuschner, at the luncheon at the Faculty Club, University of California.

Wednesday evening, immediately after the return from Stanford University, the physicists dined together at Jules Café, San Francisco. Attendance about thirty.

During the week many found opportunity to visit the exhibit of the National Bureau of Standards at the Panama-Pacific International Exposition, and some to make an excursion to the Lick Observatory at Mt. Hamilton, where the activities of the institution were explained by the astronomers in charge.

At the final session, a hearty vote of thanks was extended to the Pacific Coast Committee for the excellent arrangements made for the meetings, to the authorities of the University of California and of Stanford University for the accommodations provided and especially to the physics staff of the two institutions for the many courtesies extended by them.

A. D. COLE,
Secretary

ANNUAL MEETING OF THE AMERICAN GENETIC ASSOCIATION

THE American Genetic Association held its twelfth yearly meeting at Berkeley, Calif., August 2–6, in connection with the American Association for the Advancement of Science. More than three hundred persons attended the various conferences of the association.

The opening general meeting was held on Tuesday morning, August 3. President David Fairchild, of the U. S. Department of Agriculture, sent an opening address, in which he reminded the association that it had been organized to bring the message of genetics to the layman; to help the research worker to be more practical, and the practical breeder to be more scientific. He continued:

"The American Genetic Association is not primarily to promote research; it is to bring the biologist and the breeder together and help each to learn from the other. In my opinion, the greatest service we can do to genetics is to make its results available to the layman, and I hope to see the American Genetic Association more fully performing this service, year by year. I do not think we have fulfilled this obligation at all times as we should have done. It has been a constant temptation to coin new words, to invent methods of expressing our ideas in algebraical symbols, to present our researches in statistical form which made them a closed book to the practical breeder. All these methods are of use for the publication of original research, but in my opinion they must be supplemented by a simple account in plain English, for the benefit of those who are following our science, seeking its teaching for their own profit. They are calling on us to give them the light of science, and it is wicked to obscure this light by pedantry. I have no patience with those men of science who think their work loses dignity if it is put in simple English and made understandable to the layman. That was not the manner of Darwin, or of the other leaders of scientific thought in his generation; and if modern biology has less of a hold on the masses to-day than it had thirty years ago, if the teachings of biologists are less eagerly heard, I think we have ourselves largely to blame, and the custom which has insidiously grown on us, of describing our work in an esoteric terminology.

"I earnestly hope that the American Genetic Association can break away from this current, and stand forth as an exponent of real popularization of science. I believe the branch of science which

we represent is second to none in the importance which it has for society, and I therefore look on the growing tendency to lift this above the layman's comprehension as a calamity, in which I hope the *Journal of Heredity* will have no share."

Dr. Herbert J. Webber, of the University of California, who spoke on "Science in the Practise of Plant Breeding," remarked that the effect of the rediscovery of Mendel's Laws had often been over-emphasized. It had clarified our views, but as a fact, the segregation of characters in the second filial generation of a cross was well-known to breeders previous to 1900, and they used this knowledge constantly in their work. He emphasized the great opportunities offered to breeders by the immense number of possible combinations of unit characters, and declared that more geneticists should attack the great problem of the origin of variations—the fundamental problem of breeding, but one which most experimental breeders were neglecting. The pure line theory, he declared, offered a chance for reconciling the conflicting views of the selectionist and the hybridist. He urged that practical breeders should make themselves more familiar with morphology and cytology.

Rob R. Slocum, of the U. S. Department of Agriculture, presented a review of experimental work in poultry breeding, and declared that the results of this work did not materially modify the procedure which intelligent poultrymen had been accustomed to follow for many years. One of the greatest practical results of genetic research in poultry, he thought, was to encourage poultrymen to keep more accurate pedigrees of their fowls. His paper was illustrated by motion pictures.

E. D. Ball and Byron Alder, of the Utah Experiment Station, discussed the question "Is Egg-laying in the White Leghorn a Unit Character?" The results of their experiments at Logan, Utah, during seven years showed them that the first-year egg production of a hen is no reliable measure of what she will do in succeeding years, and that winter egg-production is not a proper measure of a hen's fecundity, being even more subject to environmental influences than yearly totals. They decided that no evidence hitherto presented by any one was adequate to answer the question whether egg-laying is a unit character.

Leon J. Cole and Frank J. Kelley, of the University of Wisconsin, described their experimental breeding work on dominant and recessive red in pigeons. The red color found in uniformly colored tumbler pigeons was found by Cole some years ago to be a simple Mendelian recessive to black. Another factor has been found, however, which has the capacity of altering the expression of black; so that birds carrying the factor for black, if they also carry this second factor, often have a distinct reddish appearance superficially resembling those individuals which are red because of the absence of black. This second factor is sex-linked.

W. S. Anderson, of the University of Kentucky, described his work in the investigation of horse breeding. Aside from the attack of such practical problems as sterility, he has investigated the lines of descent of the most famous American trotting stallions, and found that thousands "run out," to every one which shows on-breeding capacity. The importance of the dam was emphasized in this connection. Following Professor Anderson's paper, motion pictures of the horse breeding of the Bureau of Animal Husbandry, U. S. Department of Agriculture, were shown.

H. B. Frost, of the University of California, described mutation in *Mathiola annua*, a "Mendelizing" species, and reported on tests of pedigree-culture methods in Southern California.

B. O. Cowan, of Santa Monica, Calif., whose subject was "Inbreeding," concluded: "That inbreeding of live stock has brought very beneficial results can not be denied; that it is a source of danger is equally true; so if practised at all, it should be with the greatest discretion."

R. Ruggles Gates, of the University of London, spoke on "Successive Duplicate Mutations." Nilsson-Ehle first found duplicate and triplicate factors for red in wheat. Some races were found to have a single factor, giving only ratios 3 red: 1 white, others had two factors and hence gave also 15:1 ratios, while still others gave also 63:1 ratios and hence possessed three factors. It is suggested that this condition originated through mutation or chemical change having first taken place in one chromosome or pair of chromosomes. This gave the 3:1 condition. The duplicate condition arose from this afterwards, either through a similar change in another chromosome, or more probably by a mechanical re-mating of the chromosome pairs, thus giving 15:1 ratios. *Œnothera rubricalyx* similarly originated as a monohybrid through a chemical change in a chromosome, but some of the later generations have become dihybrid (giving 15:1 ratios) by a re-mating of the chromosomes. This rearrangement probably occurs at the time of fertilization rather than during meiosis.

In a second paper, Dr. Gates considered the modification of characters by crossing. Many writers hold that Mendelian characters always come out of a cross unmodified, although work by Davenport and by Castle and Phillips indicates that such is not always the case. A crucial instance of the modification of a character by crossing was furnished by various hybrids of *Œnothera rubricalyx* and *Œ. grandiflora*. In the F_2 of such crosses the red character R of the *rubricalyx* buds usually splits out sharply, but a few plants were intermediate in pigmentation, and in F_3 these bred true to the intermediate condition. Further, in (*rubricalyx* $\times$ *grandiflora*) $\times$ *grandiflora*, the depth of pigmentation of R plants is greatly diluted, though splitting takes place if the seed parent is heterozygous for R. The segregation is explained by the meiotic separation of the chromosome pairs. The dilution probably results from an inhibiting effect of the *grandiflora* chromosomes or perhaps from a modification of the R chromosome of *Œ. rubricalyx*.

A. D. Shamel, of the U. S. Department of Agriculture, spoke on the origin and development of the Washington navel orange, which he believes originated at Bahia, Brazil, nearly one hundred years ago, as a bud sport from a Portuguese variety. After a description of orange culture at Bahia and the introduction and dissemination of this variety in the United States, by the U. S. Department of Agriculture, Mr. Shamel described the origin of a number of distinct types in southern California, through bud mutation. It is believed that growers have tended to select the least productive, but most vigorous, of these sports for propagation, and the industry has therefore tended to deteriorate. Careful limb-selection of buds is now being practised, and the yield per acre is being much increased, while the character of the fruit is being improved, on the average.

E. J. Kraus, of Oregon Agricultural College, discussed self-sterility among orchard fruits. Careful observations have shown that poor production is often due to self-sterility, and that in general every variety must be tested, to find whether its own pollen is sufficient or whether it requires cross-pollination. If the latter proves to be the case, it must be tested with as many varieties as possible, to find under what conditions it succeeds best. The Oregon station has worked out detailed treatment for many of the leading varieties in its region.

In a second paper, Mr. Kraus took up the question of somatic segregation, as shown in certain varieties of pear.

The eugenics section met on the afternoon of August 3, in joint session with the American Social Hygiene Association and the Eugenics Research Association, David Starr Jordan presiding. The program, which was entirely furnished by the American Genetic Association, follows:

Irving Fisher, of Yale University, "Eugenics and Sociology." Professor Fisher discussed the mores, in their relation to eugenics, expressing a belief that the ideals of eugenics would come in some measure to be a substitute for the mores, as a criterion of morality and true value, when the race became more enlightened. At present, an action, or an institution or custom, is held to be desirable or undesirable, according as it does or does not agree with the folkways, the inherited, almost instinctive traditions of the race. In the future, people will rather ask, "Is its effect eugenic?"

Wilhelmine E. Key, of the State Training School, Polk, Pa., presented in abstract a paper on "Creating a Eugenic Conscience." She set forth conclusions based on three years of inquiry concerning eugenic ideals in all social grades. Study of extensive networks shows the operation of a fairly well-defined conscience to cut off degenerative lines and by the principle of segregation to enhance the efficiency of the better lines, in various directions. Even the embryo conscience, as illustrated by amusing instances, has worked toward this end. The rôle of eugenic laws should be to hasten the elimination of bad stock, rather than to interfere with the free choice of the average young man and woman. Too great stress on ideal fitness gives us the ingrowing eugenic conscience. It is here that feminism shows its baneful effect. Here, as elsewhere, the problem of right conduct is conditioned on right instincts. Just as current thought is becoming imbued with scientific conceptions, so we may expect that gradually the recognition of such principles as that of segregation in individual pedigrees, will lead to free conscious selection along a multitude of able lines. This will give predominance to the best-endowed strains, insure manifold variety and solve many of the problems of practical eugenics without the necessity of legal enactment, so far as society in general is concerned.

David Starr Jordan, of Stanford University, speaking on "The Long Cost of War," emphasized the reversal of natural selection which takes place

in warfare under modern conditions, and described the effect of this dysgenic factor on modern history.

Samuel C. Kohs, of the House of Correction, Chicago, taking as his subject "Eugenics and the Unconscious," warned those doing research in the heredity of human psychical traits that they were in many cases wholly superficial, and that definition of the traits which they discussed was a prerequisite of intelligent treatment. He then described some of the recent studies of the unconscious mind, which indicate that many traits in children, which are commonly believed to have been inherited from parents, might in reality be due rather to impress on the unconscious mind, during the early years of childhood. Most of the work on the inheritance of mental characters in man is of doubtful value, he declared, because of any one or more of the following reasons:

1. Inaccurate tools with which to measure the ability or capacity.
2. Amateur field workers.
3. The use of the questionnaire method.
4. Where more than one field worker was necessary for obtaining the data, the differences in the individual standards of the field workers vitiated the results.
5. Being told for what to look, and possessing the popular conceptions regarding the inheritability of all sorts of traits, it is only just to assume that many of the assistants very easily found what was not there.
6. The study of character and personality is still in its infancy. To assume that certain peculiarities are due to the presence or absence of specific determiners can, in our present state of knowledge, hardly be substantiated by actual facts.
7. Some students approach the inheritance of *mental* traits too much from a biological point of view, and therefore go astray.

A. J. Rosanoff and Helen E. Martin, of the Kings Park State Hospital, Long Island, N. Y., submitted a preliminary report of a study on the offspring of the insane, which indicates that the forms of insanity considered behave as Mendelian recessives.

Ethel H. Thayer, of the Mendocino State Hospital, Talmage, Calif., described some of the cacogenic problems of California. She mentioned that the state sterilization law is now almost inoperative, because defectively drawn so that it can not be applied to the feeble-minded, the most important of the cacogenic classes which come under its scope.

Surgeon W. C. Billings, of the U. S. Public Health Service, Angel Island (San Francisco), Calif., described in some detail the administration of the immigration laws at California ports. Nearly all the immigrants are Asiatics, and therefore offer little of importance to eugenics, because marriages between them and the white population of the United States are extremely rare.

Walter B. Swift, in charge of the Voice Clinic of the Boston State Hospital, spoke on the possibility of voice inheritance. He discussed the inheritance of bone forms and body shapes as a basis upon which to build. The transmission of bone cavities as a further foundation. Consideration of the Indians' "high cheek bones" and the straight front nose of the Greek. The equine nose as found in the Jew. Such transmissions of bony exteriors—as an indication that cavities they contain are also inherited at least in some measure. If cavities are inherited then vocal elements based upon cavity formation for their fundamental qualities and overtones may also possibly be transmitted. Evidence from other sources. Illustrative cases.

The plant breeding section met all day on August 5, hearing the following papers:

Ernest B. Babcock, University of California, described walnut mutant investigations. "In 1912 I discovered an apparently normal tree of the California black walnut which annually bears a good crop of nuts, most of which when planted produce typical black walnuts, but a few of which produce a new type of walnut which I have named *quercina* because of its general resemblance to a small-leaved oak. This tree is probably the only perennial mutating individual accessible for experimentation. By using root-tips from these two types of seedlings we have ascertained the number of chromosomes characteristic of each and that the number is the same for both, thirty-four. Hence the mutation must be due to some other cause than a change in chromosome number. Breeding experiments are under way which may throw light on the nature of this mutation."

L. D. Batchelor, University of California, explaining problems in walnut breeding, pointed out that most of the Persian (English) walnut groves of California are composed of seedlings, and that these must be worked over to the best strains, if the industry is to have its maximum efficiency.

Howard Gilkey, of the University of California, emphasized the need for breeding ornamentals that would meet the landscape gardener's requirement of definite types of form.

Francis E. Lloyd, of McGill University, described his study of the Japanese persimmon, in which he found the presence of an emulsion colloid, which when it coagulated not only fixed the tannin, thus making the fruit palatable, but also caused a change in color of the flesh. In a second paper on "Intra-ovarial Treatments: Methods and Results," he said: "In pursuance of earlier investigations, and in the hope of reaching the egg-cell directly by means of reagents which might possibly permanently disturb the germ-plasm, *Torenia Fourneri* has been studied. In spite of the protuberant embryo-sac, bringing the egg-apparatus into a position of apparently maximum exposure, its position in contact with the placenta, together with other mechanical relations, precludes the object sought. The course of reagents (using methylene blue as a criterion) injected into the placenta is essentially identical with that earlier described for *Scrophularia* (Carn. Inst. Wash., Ann. Rep. 1914, p. 77). It has further been discovered that the mutual adjustments of the elements of the egg-apparatus and embryo-sac, which show a diffusion pressure equivalent to that of a $0.1N$ $KNO3$ solution, are so delicate that access to tap-water is followed by bursting of the synergidæ and partial extrusion of the hydrocellulosic beak material, thus precluding the use of dilute watery solutions in immediate contact with the embryo-sac."

Sarkis Boshnakian, of Cornell University, described a new checkerboard method of representing Mendelian segregation, and gave a coefficient of squarehead form necessary for the statistical study of density in wheat.

W. B. McCallum, of San Diego, Calif., described the cultivation of several million plants of guayule (*Parthenum argentatum*), a Mexican plant which produces rubber. Although regarded as a single species, the plant has been found to have at least 125 forms, varying widely and all breeding true.

E. F. Gaines, Washington State Experiment Station, gave a brief account of results obtained by crossing wheats and barleys differing in two or more unit factors. Both dominance and lack of dominance have been secured in different cases, and one case of triplicate identical factors, cumulative in effect, was reported.

C. C. Vincent, Idaho Experiment Station, made a preliminary report on apple-breeding projects at that station. He told of the need of new varieties and described some thousands of crosses that have been made.

H. E. Knowlton, of Cornell University, describing studies in pollen germination with special reference to longevity, reported that pollen of the snapdragon (*Antirrhinum majus*) remained viable longest when kept at low temperature. Pollen stored at — 17° to — 23° C. for six weeks gave a fair percentage of germination in sugar solution, and moreover some of the flowers pollinated with it produced seeds.

Arthur W. Gilbert, Cornell University, "Color Inheritance in *Phlox drummondi*." "The following unit characters were found in the four varieties of *Phlox drummondi* that were used in these experiments: (1) A dark eye factor producing a dense coloration at the center of the flower. This was dominant over its absence, the white eye, which was exhibited in more or less of a definite pattern. (2) A blue factor. (3) A red factor. (4) An intensifying factor which determines the degree of pigmentation of the reds. (5) A yellow factor which acts only in the presence of the eye factor. The reds and blues are cell-sap colors, and the yellow is due to the presence of yellow chromoplasts."

Alfred C. Hottes, of Cornell University, discussed the practical hybridization of the gladiolus. It is a genus of about one hundred and thirty species, mostly natives of South Africa, a few from Europe. Approximately fifteen species have been cultivated or used in hybridization, so that this flower offers an excellent example of a flower improved by the incorporation of a number of species. The work has been carried on chiefly without reference to laws of inheritance; each species has transmitted to some hybrid a desirable feature which has been selected and impressed upon other hybrids.

George F. Freeman, of the University of Arizona, "Inheritance of Quality in Wheat." A number of recent investigators have declared that wheat quality is dependent on environment, and that the breeder could not control it. Careful review of all the work done shows this conclusion to be erroneous. Qualitative factors in wheat are to a large degree dependable and controllable.

John W. Gilmore, of the University of California, illustrated the wide variability of rye grasses and told of the possibilities for the practical breeder.

George L. Zundel, Cornell University, spoke on disease resistance in celery. Preliminary experiments were carried on at Cornell University by the writer to test the relative susceptibility of varieties of celery to the fungus *Septoria petroselini* Desm. var. *apii* Br. et Cav. No variety was

found to be resistant to the fungus, but individual plants were found that were nearly immune. Since the celery flower is self-pollinated a method for future work is at once suggested, *e. g.*, the selection of the immune plants as parents upon which to build immune strains of celery.

In a second paper, Mr. Zundel discussed the evolution of celery. Celery has been known to mankind for centuries. The Greeks and Romans used it mostly as a medical plant. They attributed to it great curative powers. Its native habitat is given as ranging from Sweden to the Mediterranean and into British India. It is known botanically as *Apium graveolens* L. The early English name for celery was smallage and later it was known as salary. The Greeks called it *Eliosclinon* or marsh parsley. Abercombie, in 1778, gives the first list of named varieties of celery. He gives four varieties, all of which originated on the large estates of titled gentlemen. Celery was at this time regarded as a luxury for the tables of titled gentlemen. The introduction, about 1883, of the Golden Self Blanching and White Plume celery revolutionized the celery industry of America.

G. P. Rixford, of the U. S. Department of Agriculture, told of the pistachio nut, which he believes will become a crop of some importance in parts of the south and west.

C. O. Smith, of the University of California, gave particulars of a method of inoculating plants to determine their comparative resistance to disease, in breeding work.

Frank S. Harris and J. C. Hogenson, Utah Agricultural College, discussed some correlations in sugar beets. It was found that the larger beets had the smaller sugar content; a number of other correlations were cited, which facilitate beet breeding.

G. N. Collins and J. H. Kempton, of the U. S. Department of Agriculture, described a bigeneric grass hybrid (*Tripsacum dactyloides* × *Euchlæne mexicana*) which shows no trace of the influence of the seed parent. Some reasons were given for thinking that it is not parthenogenetic.

W. A. Setchell and T. H. Goodspeed, of the University of California, conducted the meeting on a tour of their tobacco-breeding experiments.

At the closing general session of the association, Friday afternoon, August 6, Mrs. Myrtle Shepherd Francis, of Ventura, Calif., related her experience in breeding double seeding Petunias, and exhibited specimens.

H. Hayward, Delaware Experiment Station, spoke on inbreeding. Pearl's method for measuring accurately the degree to which an animal is inbred has caused a revision of many ideas on the subject. It has been found, for instance, that some of the famous sires of Bates, Booth and the Collings, were not nearly as much inbred as is popularly supposed. Breeding experiments with pigs, conducted at the Delaware station under careful control, have satisfied the speaker that when inbreeding is carried beyond a certain point, deterioration is inevitable. It is difficult to fix any arbitrary point, however, as the limit of safety.

Isabel McCracken, of Stanford University, described Mendelian breeding experiments with silkworms.

J. H. Kempton, of the U. S. Department of Agriculture, described the result of a long series of breeding experiments with maize.

Albert F. Etter, of Briceland, Calif., told of his work in strawberry breeding, in which he has crossed commercial varieties with the beach strawberry of the Pacific coast, with the alpine species, and others. Plants much more resistant and productive than any present commercial variety have been obtained, and the berries offer a wide range of desirable commercial characters.

C. L. Redfield, of Chicago, defended his theory of dynamic evolution, maintaining that such functional qualities as speed in race horses, or milk-production in cows, are developed by work and that the results of this development are then transmitted to the offspring. He declared that no single instance has ever been cited where this rule was violated.

C. L. Lewis, of the Oregon Agricultural College, speaking on plant-breeding problems of the Pacific Coast, declared it was a mistake to think there were plenty of good varieties of fruit already in existence; that in nearly every field the geneticist was needed. He cited many cases to prove his point.

It was decided to continue holding the meetings of the American Genetic Association in connection with those of the American Association for the Advancement of Science. A committee headed by Herbert J. Webber and comprising R. Ruggles Gates, George H. Shull, W. E. Castle, Raymond Pearl, H. S. Jennings and Paul Popenoe, was appointed on nomenclature, with the particular request that it consider suitable definitions of inbreeding and linebreeding, which could be agreed on by genetists and practical breeders, and relieve the confusion which now attends the use of these two words.

Paul Popenoe,
Secretary pro tem.

SCIENCE

FRIDAY, SEPTEMBER 24, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE COMMON AIMS OF SCIENCE AND HUMANITY[1]

UNDER the influence of the diversity of pursuits imposed upon us by the conditions of modern life, different groups of the community—men of business, men of science, philosophers or artists—have acquired detached and sometimes opposing interests. Each group, impressed by the importance of its own domain in the life of the nation, and focusing its vision on small differences and temporary rivalries, was in danger of losing the sense of mutual dependence. But in the shadow of a great catastrophe it has been brought home to us that the clash of interests is superficial, and the slender thread of union which remained has grown into a solid bond. What is the fiber from which the bond is twined? Patriotism may express its outward manifestation, but its staple is the mental relationship which remains continuous and dominant even in normal times, when each of us may peacefully go to earn his living and enjoy the course of his intellectual life.

Outwardly the community is divided into heterogeneous elements with mental attitudes cast in different moulds, and proceeding along separate roads by differing methods to different ideals. Yet as we eliminate the superficial, and regard only the deep-seated emotions which control our thoughts and actions, the differences vanish, and the unity of purpose and sentiment emerges more and more strongly. Mind and character, no doubt, group themselves into a number of types, but the cleavage runs

[1] Address of the President of the British Association for the Advancement of Science, Manchester, 1915.

across, and not along, the separating line of professions.

Were it otherwise, the British Association could not perform one of its most important functions—a function not, indeed, originally contemplated, but resulting indirectly from the wise and democratic provisions in its constitution, which enabled it to adapt itself to the changing needs of the time. Our founders primarily considered the interests of scientific men; their outlook was restricted and exclusive, both as regards range of subject and membership. In the words of Sir David Brewster, who gave the first impulse to its formation, it was to be "an Association of our nobility, clergy, gentry and philosophers."

The meetings were intended to promote personal intercourse, to organize research, to advocate reform of the laws hindering research, and to improve the status of scientific men. The right of membership was confined to those who already belonged to some learned society, and William Whewell, one of the principal supporters of the movement, even suggested that only authors of memoirs published by a learned society should be admitted.[2] He emphasized this proposal by the recommendation[3] "in some way to avoid the crowd of lay members whose names stand on the List of the Royal Society." The reform of the Patent Laws and the introduction of an International Copyright were suggested as subjects suitable for discussion, not apparently from the point of view of general advantage, but merely in the interests of one section of the community.

Whatever the objects of the founders of the association may have been, it is obvious that questions of public importance could not be permanently excluded from meetings the success of which depended on the interest stimulated in the community. The statistical section, which owed its origin to the visit, at the first Oxford meeting (1836), of Quetelet, the Belgian astronomer and economist, was the first to assert itself by engaging in a discussion of the Poor Laws. Whewell deeply resented this violation of academic neutrality: "it was impossible," he wrote, "to listen to the Proceedings of the Statistical Section on Friday without perceiving that they involved exactly what it was most necessary and most desired to exclude from our Proceedings,"[4] and again: "Who would propose (I put it to Chalmers, and he allowed the proposal to be intolerable) an ambulatory body, composed partly of men of reputation and partly of a miscellaneous crowd, to go round year by year from town to town and at each place to discuss the most inflammatory and agitating questions of the day?"[5]

Fortunately for our association, this narrow-minded attitude did not prevail, and our records show that while not avoiding controversial and even inflammatory subjects, we have been able to exercise a powerful influence on the progress of science. The establishment of electric units, universally accepted throughout the world, originated in the work of one of our committees; the efforts which led to the foundation of the National Physical Laboratory, one of the most efficient and beneficial organizations in the country, received its first impulses from us; and the organization of the first world service for the systematic investigation of earth tremors was established by

[2] Others were allowed to join on recommendation by the General Committee. It was only in 1906 that this restriction, which had become obsolete, was removed.

[3] Whewell's "Writings and Letters," Vol. II., p. 128.

[4] *Loc. cit.*, p. 289.

[5] It is much to be desired that the documents relating to the early history of the British Association should be published in a collected form.

the late Dr. Milne, working through one of our committees.

The success of these enterprises alone is sufficient to show that we are not merely a body promoting social intercourse between men of science and the rest of the community. Nevertheless, it may be admitted that our efforts have been spasmodic, and the time has arrived to consider whether it may be possible to secure not only a greater continuity in our work but also its better coordination with that of other scientific organizations. The present juncture affords the opportunity, and the changed conditions, which in the near future will affect all our institutions, render it indeed incumbent upon us once more to adapt ourselves to the needs of the times. Proposals for a move in that direction have already been made, and will no doubt be carefully considered by the council. In the meantime, I may draw your attention to the important discussions arranged for by our Economic Section, which alone will justify the decision of the council not to suspend the meeting this year.

It must not be supposed that, even in the early days of the association, Whewell's ideas of its functions were universally accepted. It is pleasant to contrast the lamentations of the omniscient professor of mineralogy with the weightier opinion of the distinguished mathematician who then held Newton's chair at Cambridge. At the concluding session of the second meeting of the association, Babbage expressed the hope "that in the selection of the places at which the annual meetings were to be held, attention should be paid to the object of bringing theoretical science in contact with the practical knowledge on which the wealth of the country depends." "I was myself," he said, "particularly anxious for this, owing as I do a debt of gratitude for the valuable information which I have received in many of the manufacturing districts, where I have learned to appreciate still more highly than before the value of those speculative pursuits which we follow in our academical labors. I was one of those who thought at first that we ought to adjourn for our next meeting to some large manufacturing town; but I am now satisfied that the arrangement which has been made will be best adapted to the present state of the association. When, however, it shall be completely consolidated I trust we may be enabled to cultivate with the commercial interests of the country that close acquaintance which I am confident will be highly advantageous to our more abstract pursuits."

Since then, as we all know, our most successful meetings have been held in manufacturing centers; but it is important to note that, while Babbage laid stress on the benefit which would accrue to pure science by being brought into contact with practical life, scientific men of the present day have more and more insisted on the services they, on their part, are able to render to the industries. The idealistic motive has thus given way to the materialistic purpose. Both aspects are perhaps equally important, but it is necessary to insist, at the present time, that the utilitarian drum can be beaten too loudly. There is more than one point of contact between different activities of the human mind, such as find expression in scientific pursuits or commercial enterprises, and it is wrong to base the advantages to be derived from their mutual influence solely, or even mainly, on the ground of material benefits.

I need not press this point in a city which has given many proofs that a business community may be prompted by higher motives than those which affect their pockets. It was not for utilitarian objects that repeated efforts were made since the year 1640 to establish a University in Man-

chester; it was not for reasons of material gain that the Royal Institution and Owens College were founded; nor was it because they increased the wealth of the district that the place of honor in our Town Hall has been given to Dalton and Joule.

When we glance at the various occupations of the working parts of a nation, comprising the student who accumulates or extends knowledge, the engineer who applies that knowledge, the geologist or agriculturist who discloses the store of wealth hidden in the soil, the commercial man who distributes that wealth, it seems as if we ought to be able to name the qualities of intellect and temperament which in each pursuit are most needed to carry out the work successfully. But on trying to define these qualities we soon discover the formidable nature of the task. Reasoning power, inventive power, and sound balance of judgment are essential attributes in all cases, and the problem is reduced to the question whether there are different varieties of the attributes which can be assigned to the different occupations.

Among all subjects mathematics is perhaps the one that appears most definitely to require a special and uncommon faculty. Yet, Poincaré—himself one of the clearest thinkers and most brilliant exponents of the subject—almost failed when he attempted to fix the distinguishing intellectual quality of the mathematician. Starting from the incontrovertible proposition that there is only one kind of correct reasoning, which is logical reasoning, he raises the question why it is that everybody who is capable of reasoning correctly is not also a mathematician, and he is led to the conclusion that the characterizing feature is a peculiar type of memory. It is not a better memory, for some mathematicians are very forgetful, and many of them can not add a column of figures correctly; but it is a memory which fixes the order in which the successive steps of reasoning follow each other without necessarily retaining the details of the individual steps. This Poincaré illustrates by contrasting the memory of a chess-player with that of a mathematician. "When I play chess," he says, "I reason out correctly that if I were to make a certain move, I should expose myself to a certain danger. I should, therefore, consider a number of other moves, and, after rejecting each of them in turn, I should end by making the one which I first contemplated and dismissed, having forgotten in the meantime the ground on which I had abandoned it." "Why, then," he continues, "does my memory not fail me in a difficult mathematical reasoning in which the majority of chess-players would be entirely lost? It is because a mathematical demonstration is not a juxtaposition of syllogisms, but consists of syllogisms placed in a certain order; and the order in which its elements are placed is much more important than the elements themselves. If I have this intuition—so to speak—of the order, so as to perceive at one glance the whole of the reasoning, I need not fear to forget its elements: each of these will take its right place of its own accord without making any call on my memory."[6]

Poincaré next discusses the nature of the intellectual gift distinguishing those who can enrich knowledge with new and fertile ideas of discovery. Mathematical invention, according to him, does not consist in forming new combinations of known mathematical entities, because the number of combinations one could form are infinite, and most of them would possess no interest whatever. Inventing consists, on the contrary, in excluding useless combinations, and therefore: "To invent is to select—to choose." . . . "The expression 'choose'

[6] "Science et Méthode," pp. 46 and 47.

perhaps requires qualifying, because it recalls a buyer to whom one offers a large number of samples which he examines before making his choice. In our case the samples would be so numerous that a lifetime would not suffice to complete the examination. That is not the way things are done. The sterile combinations never present themselves to the mind of the inventor, and even those which momentarily enter his consciousness, only to be rejected, partake something of the character of useful combinations. The inventor is therefore to be compared with an examiner who has only to deal with candidates who have already passed a previous test of competence."

All those who have attempted to add something to knowledge must recognize that there is a profound truth in these remarks. New ideas may float across our consciousness, but, selecting the wrong ones for more detailed study, we waste our time fruitlessly. We are bewildered by the multitude of roads which open out before us, and, like Poincaré when he tries to play chess, lose the game because we make the wrong move. Do we not all remember how, after the announcement of a new fact or generalization, there are always many who claim to have had, and perhaps vaguely expressed, the same idea? They put it down to bad luck that they have not pursued it, but they have failed precisely in what, according to Poincaré, is the essence of inventive power. It may be bad luck not to have had a good idea, but to have had it and failed to appreciate its importance is downright incapacity.

An objection may be raised that before a selection can be made the ideas themselves must appear, and that, even should they arrive in sufficient numbers, the right one may not be among them. It may even be argued that Poincaré gives his case away by saying that "the sterile combinations do not even present themselves to the mind of the inventor," putting into a negative form what may be the essence of the matter. Moreover, a fertile mind like that of Poincaré would be apt to place too low a value on his own exceptional gifts. Nevertheless, if Poincaré's more detailed exposition be read attentively, and more especially the description of how the discoveries which made him famous among mathematicians originated in his mind, it will be found that his judgment is well considered and should not be lightly set aside. New ideas seldom are born out of nothing. They most frequently are based on analogies, or the recollection of a sequence of thoughts suggested by a different branch of the subject, or perhaps by a different subject altogether. It is here that the memory comes in, which is not a memory of detail, but a memory of premises with their conclusions, detached from the particular case to which they were originally applied. Before we pronounce an adverse opinion on Poincaré's judgment, we must investigate what constitutes novelty in a new idea, but the subject is too vast to be dealt with here, nor can I attempt to discuss whether an essential distinction exists between mathematical invention and that more practical form of invention with which, for instance, the engineer has to deal.

If Poincaré, by this introspective analysis of his own powers, has dimmed the aureole which, in the eyes of the public, surrounds the mathematician's head, he removes it altogether by his definition of mathematics. According to him, "mathematics is the art of calling two different things by the same name." It would take me too far were I to try to explain the deep truth expressed in this apparently flippant form: physicists, at any rate, will remember the revolution created in the fundamental outlook of science by the application of the

term "energy" to the two quite distinct conceptions involved in its subdivisions into potential and kinetic energy.

Enough has been said to show that the peculiar powers necessary for the study of one of the most abstract branches of knowledge may be expressed in terms which bring them down to the level at which comparison with other subjects is possible. Applying the same reasoning to other occupations, the same conclusion is inevitable. The commercial man, the politician and the artist must all possess the type of memory best suited to concentrate in the field of mental vision their own experiences as well as what they have learned from the experience of others; and, further, they must have the power of selecting out of a multitude of possible lines of action the one that leads to success; it is this power which Poincaré calls the inventive faculty.

The argument must not be pushed too far, as it would be absurd to affirm that all differences in the capability of dealing successfully with the peculiar problems that occur in the various professions may be reduced to peculiarities of memory. I do not even wish to assert that Poincaré's conclusions should be accepted without qualification in the special case discussed by him. What is essential, to my mind, is to treat the question seriously, and to dismiss the vague generalities which, by drawing an artificial barrier between different groups of professions, try to cure real or imaginary defects through plausible though quite illusory remedies. All these recommendations are based on the fallacy that special gifts are associated with different occupations. Sometimes we are recommended to hand over the affairs of the nation to men of business; sometimes we are told that salvation can only be found in scientific methods—what is a man of business, and what is a scientific method? If you define a man of business to be one capable of managing large and complicated transactions, the inference becomes self-evident; but if it be asserted that only the specialized training in commercial transactions can develop the requisite faculties, the only proof of the claim that could be valid would be the one that would show that the great majority of successful statesmen, or political leaders, owed their success to their commercial experience. On the other hand, every method that leads to a correct result must be called a scientific method, and what requires substantiating is that scientific training is better than other training for discovering the correct method. This proof, as well as the other, has not been, and, I think, can not be, given. When, therefore, one man calls for the conduct of affairs "on business lines" and the other clamors for scientific methods, they either want the same thing or they talk nonsense. The weak point of these assertions contrasting different classes of human efforts is that each class selects its own strongest men for comparison with the weakest on the other side.

The most fatal distinction that can be made is the one which brings men of theory into opposition to men of practise, without regard to the obvious truth that nothing of value is ever done which does not involve both theory and practise; while theory is sometimes overbearing and irritating, there are among those who jeer at it some to whom Disraeli's definition applies: the practical man is the man who practises the errors of his forefathers. With refined cruelty Nemesis infects us with the disease most nearly akin to that which it pleases us to detect in others. It is the most dogmatic of dogmatics who tirades against dogma, and only the most hopeless of theorists can declare that a thing may be right in theory and wrong in practise.

Why does a theory ever fail, though it

may be sound in reasoning? It can only do so because every problem involves a much larger number of conditions than those which the investigator can take into account. He therefore rejects those which he believes to be unessential, and if his judgment is at fault he goes wrong. But the practical man will often fail for the same reason. When not supported by theoretical knowledge he generalizes the result of an observation or experiment, applying it to cases where the result is determined by an altogether different set of conditions. To be infallible the theorist would have to take account of an infinite number of circumstances, and his calculations would become unmanageable, while the experimenter would have to perform an infinite number of experiments, and both would only be able to draw correct conclusions after an infinite lapse of time. They have to trust their intuition in selecting what can be omitted with impunity, and, if they fail, it is mainly due to the same defect of judgment. And so it is in all professions: failure results from the omission of essential considerations which change the venue of the problem.

Though theory and practise can only come into opposition when one of them is at fault, there is undoubtedly a contrast in character and temperament between those who incline more towards the one and those who prefer the other aspect: some like a solitary life at the desk, while others enjoy being brought into contact with their fellows. There have at all times been men predestined by nature to be leaders, and leadership is required in all branches of knowledge—the theoretical as well as the more active pursuits; but we must guard against accepting a man's estimate of his own power to convert his thoughts into acts. In the ordinary affairs of life a man who calls himself a man of action is frequently only one who can not give any reasons for his actions. To claim that title justly a man must act deliberately, have confidence in his own judgment, sufficient tenacity of purpose to carry it through, and sufficient courage to run the unavoidable risks of possible failure. These risks may be trivial or they may be all-important. They may affect the reputation of one unit of creation or involve the whole life of a nation, and according to the greatness of the issue we shall honor the man who, having taken the risk, succeeds. But whether the scale be microscopic or interstellar, the essence of the faculty of blending theory and practise is the same, and both men of books and men of action are to be found in the philosopher's study and the laboratory, as well as in the workshop or on the battlefield. Modern science began, not at the date of this or that discovery, but on the day that Galileo decided to publish his Dialogues in the language of his nation. This was a deliberate act destined to change the whole aspect of science which, ceasing to be the occupation of a privileged class, became the property of the community. Can you, therefore, deny the claim of being a man of action to Galileo, can you deny it to Pasteur, Kelvin, Lister, and a host of others? There are, no doubt, philosophers who can not manage even their own affairs, and whom it would be correct to call pure theorists, but that proves nothing, because their defect makes them worse philosophers as well as worse citizens.

In his Presidential Address, delivered to this association in 1899, Sir Michael Foster summarized the essential features of the scientific mind. Above all other things he considered that its nature should be such as to vibrate in unison with what it is in search of; further, it must possess alertness, and finally moral courage. Yet after enumerating these qualities, he arrives at the same

result which I have tried to place before you, that there are no special peculiarities inherent in the scientific mind, and he expresses this conclusion in the following words:

> But, I hear some one say, these qualities are not the peculiar attributes of the man of science, they may be recognized as belonging to almost every-one who has commanded or deserved success, whatever may have been his walk in life. That is so. That is exactly what I would desire to insist, that the men of science have no peculiar virtues, no special powers. They are ordinary men, their characters are common, even commonplace. Science, as Huxley said, is organized common-sense, and men of science are common men drilled in the ways of common-sense.

This saying of Huxley's has been repeated so often that one almost wishes it were true, but unfortunately I can not find a definition of common-sense that fits the phrase. Sometimes the word is used as if it were identical with *uncommon* sense, sometimes as if it were the same thing as common *nonsense*. Often it means untrained intelligence, and in its best aspect it is, I think, that faculty which recognizes that the obvious solution of a problem is frequently the right one. When, for instance, I see, during a total solar eclipse, red flames shooting out from the edge of the sun, the obvious explanation is that these are real phenomena caused by masses of glowing vapors ejected from the sun; and when a learned friend tells me that all this is an optical illusion due to anomalous refraction, I object on the ground that the explanation violates my common-sense. He replies by giving me the reasons which have led him to his conclusions, and, though I still believe that I am right, I have to meet him with a more substantial reply than an appeal to my own convictions. Against a solid argument common-sense has no power and must remain a useful but fallible guide which both leads and misleads all classes of the community alike.[7]

If we must avoid assuming special intellectual qualities when we speak of groups of men within one country, we ought to be doubly careful not to do so without good reason in comparing different nations. So-called national characteristics are in many cases matters of education and training; and, if I select one as an example, it is because it figures so largely in public discussions at the present moment. I refer to that expedient for combining individual efforts which goes by the name of organization. An efficient organization requires a head that directs and a body that obeys; it works mainly through discipline, which is its most essential attribute. Every institution, every factor, every business establishment is a complicated organism, and no country ever came to prominence in any walk of life unless it possessed the ability to provide for the efficient working of such organisms. To say that a nation which has acquired and maintained an empire, and which conducts a large trade in every part of the world, is deficient in organizing power is therefore an absurdity. Much of the current self-depreciation in this respect is due to the confusion of what constitutes a true organization with that modification of it which to a great extent casts aside discipline and substitutes cooperation. Though much may be accomplished by cooperation, it is full of danger in an emergency, for it can only work if it be loyally adhered to; otherwise it resembles a six-cylinder motor in which every sparking-plug is allowed to fix its own time of firing. Things go well so long as the plugs agree; but there is nearly always one among them that persists in taking an independent course and, when the machine stops, complains that the

[7] Since writing the above, I find on reading Professor J. A. Thomson's "Introduction to Science" a similar criticism of Huxley's dictum. Professor Thomson's general conclusions are not, however, in agreement with those here advocated.

driver is inefficient. The cry for organization, justifiable as it no doubt often is, resolves itself, therefore, into a cry for increased discipline, by which I do not mean the discipline enforced at the point of the bayonet, but that accepted by the individual who voluntarily subordinates his personal convictions to the will of a properly constituted authority. This discipline is not an inborn quality which belongs more to one nation than to another; it is acquired by education and training. In an emergency it is essential to success, but if it be made the guiding principle of a nation's activity, it carries dangers with it which are greater than the benefits conferred by the increased facility for advance in some directions.

If there be no fundamental difference in the mental qualifications which lead to success in our different occupations, there is also none in the ideals which move us in childhood, maintain us through the difficulties of our manhood, and give us peace in old age. I am not speaking now of those ideals which may simultaneously incite a whole nation to combined action through religious fervor or ambition of power, but I am speaking of those more individual ideals which make us choose our professions and give us pleasure in the performance of our duties.

Why does a scientific man find satisfaction in studying nature? Let me once more quote Poincaré:[8]

> The student does not study Nature because that study is useful, but because it gives him pleasure, and it gives him pleasure because Nature is beautiful; if it were not beautiful it would not be worth knowing and life would not be worth living. I am not speaking, be it understood, of the beauty of its outward appearance—not that I despise it, far from it, but it has nothing to do with science: I mean that more intimate beauty which depends on the harmony in the order of the component parts of Nature. This is the beauty which a pure intelligence can appreciate and which gives substance and form to the scintillating impressions that charm our senses. Without this intellectual support the beauty of the fugitive dreams inspired by sensual impressions could only be imperfect, because it would be indecisive and always vanishing. It is this intellectual and self-sufficing beauty, perhaps more than the future welfare of humanity, that impels the scientific man to condemn himself to long and tedious studies. And the same search for the sense of harmony in the world leads us to select the facts which can most suitably enhance it, just as the artist chooses among the features of his model those that make the portrait and give it character and life. There need be no fear that this instinctive and unconscious motive should tempt the man of science away from the truth, for the real world is far more beautiful than any vision of his dreams. The greatest artists that ever lived—the Greeks—constructed a heaven; yet how paltry that heaven is compared to ours! And it is because simplicity and grandeur are beautiful that we select by preference the simplest and grandest facts, and find our highest pleasure, sometimes in following the gigantic orbits of the stars, sometimes in the microscopic study of that minuteness which also is a grandeur, and sometimes in piercing the secrets of geological times which attract us because they are remote. And we see that the cult of the beautiful guides us to the same goal as the study of the useful.
>
> Whence comes this harmony? Is it that things that appear to us as beautiful are simply those which adapt themselves best to our intelligence, and are therefore the tools which that intelligence handles most easily; or is it all the play of evolution and natural selection? In that case, those races only survived whose ideals best conformed with their interests, and while all nations pursued their ideals without regard to consequences, some were led to perdition and others achieved an empire. One is tempted to believe that such has been the course of history, and that the Greeks triumphed over the barbarians, and Europe, inheritor of Greek thought, rules the world, because the savages cared only for the sensual enjoyment of garish colors and the blatant noise of the drum, while the Greeks loved the intellectual beauty which is hidden beneath the visible beauty. It is that higher beauty which produces a clear and strong intelligence.

If the mathematician's imagination is fired by the beauty and symmetry of his

[8] *Loc. cit.*, p. 15.

methods, if the moving spring of his action is identical with that of the artist, how much truer is this of the man of science who tries by well-designed experiments to reveal the hidden harmonies of nature? Nor would it be difficult, I think, to trace the gratification inherent in the successful accomplishments of other intellectual pursuits to the same source.

Though Poincaré was, I believe, the first to lay stress on the connection between the search for the beautiful and the achievement of the useful, the esthetic value of the study of science had previously been pointed out, and well illustrated, by Karl Pearson in his "Grammar of Science." As expressed by him: "it is this continual gratification of the esthetic judgment which is one of the chief delights of pure science." Before we advance, however, any special claim for the pursuit of science based on these considerations, we must pause to think whether they do not equally apply to other studies or occupations. For this purpose, the nature of the esthetic enjoyment involved must be remembered. We do not mean by it, the pleasure we feel in the mere contemplation of an impressive landscape or natural beauty, but it resembles more the enjoyment experienced on looking at a picture where, apart from the sensual pleasure, we are affected by the relation between the result of the representation and that which is represented. The picture, quite apart from what it may be trying to imitate, has a certain beauty due to its contrast of colors or well-balanced arrangement. We have in one case a number of pigments covering a space of two dimensions, and in the other the natural object in three dimensions made up of entirely different materials and showing an infinite variety of detail and appearance. By itself alone either a mere photographic representation or a geometrical arrangement of color and line, leaves most of us cold; though both have their own particular beauty, the art consists in bringing them into connection. Bearing in mind the esthetic value of the relationship of the work of our brain or hand to external facts or appearances, it might easily be shown that what has been said of science equally applies to other studies, such as history or literature. We may even go further, and say that any occupation whatever, from which we can derive an intellectual pleasure, must possess to a greater or smaller degree the elements of combining the useful with the beautiful.

In order to trace in detail the part played by purely emotional instincts in directing the course of our lives, we should have to study the causes which influence a child, free to select his future profession. Having eliminated secondary effects, such as early associations, or the personal influence of an inspiring teacher, we should probably be brought to a standstill by the dearth of material at our disposal, or led into error by taking our own individual recollections as typical. Nevertheless it is only through the record of each man's experience that we may hope to arrive at a result. If every man who has reached a certain recognized position in his own subject—it need not be preeminence—would write down his own recollections of what led him to make the choice of his profession, we might hope to obtain facts on which a useful psychological study might be based. Scientific men as a class are not modest, but they share with other classes the reluctance to speak of their early life, owing to a certain shyness to disclose early ambitions which have not been realized. It requires courage to overcome that shyness, but I think that we need feel no shame in revealing the dreams of our childhood and holding fast to them despite the bondage of our

weakness, despite the strife ending so often in defeat, despite all the obstacles which the struggle for existence has placed in our path. In some form they should persist throughout our lives and sustain us in our old age.

But the account of our early life should be simple, detached from any motives of self-depreciation or self-assertion, and free from any desire to push any particular moral or psychological theory. We want to trace the dawn of ambition, the first glimmering in the child's mind that there is something that he can do better than his fellows and reminiscences of early likes and dislikes which, though apparently disconnected from maturer tendencies, may serve as indications of a deep-seated purpose in life. It may be difficult to resist the temptation of trying to justify one's reputation in the eyes of the world; but it is worth making the effort. The only example that I know of such an autobiographical sketch is that of Darwin, which is contained in his "Life and Letters," published by his son, Sir Francis Darwin.

The ambition of a child to be better, cleverer, or more beautiful than its fellows is in the main, I think, a wish to please and to be praised. As the child grows up, the ambition becomes more definite. It is not a sordid ambition for ultimate wealth or power, nor is it an altruistic ambition to do good for the sake of doing good. Occasionally it takes the form confessed to by Darwin, when he says: "As a child I was much given to inventing deliberate falsehoods, and this was always done for the sake of causing excitement." This desire to be conspicuous was, in Darwin's case, consistent with extreme modesty, amounting almost to a want of confidence in himself, as appears in this passage: "I remember one of my sporting friends, Turner, who saw me at work with my beetles, saying that I should some day be a Fellow of the Royal Society, and this notion seemed to me to be preposterous."

We next come to the stage where a child is attracted by one subject more than another, and, if his choice be free, will select it for his life's career. What guides him in this choice? If it be said that a boy gravitates towards that subject which he finds easiest, we are led to the further question why does he find it easiest? It is on this point that more information is required, but I am inclined to answer in accordance with Poincaré's views that it is because its particular beauty appeals most strongly to his emotional senses. In questions of this kind everyone must form his own conclusions according to his personal recollections, and these convince me that the emotional factor appears already at an early age. It is the strong attraction towards particular forms of reasoning, more perhaps even than the facility with which reasoning comes, that carries us over the initial difficulties and the drudgery that must accompany every serious study.

I have already alluded to the different tendencies of individuals either to prefer solitary reflection or to seek companionship. Almost in every profession we find men of both types. Darwin's autobiography furnishes a good example of the man who prefers to learn through quiet reading rather than through lectures, but to many men of science the spoken word is inspiring and contact with congenial minds almost a necessity.

From our present point of view the most interesting passages in Darwin's autobiography are those indicating the esthetic feeling which, like Poincaré, he connects with scientific research. Referring to his early studies we find this passage: "I was taught by a private tutor and I distinctly remember the intense satisfaction which the clear

geometrical proofs gave me. I remember with equal distinctness the delight which my uncle gave me by explaining the principle of the vernier of a barometer." To a man who apparently had no pronounced facility of mastering mathematical difficulties this feeling of satisfaction is especially remarkable. The combination of scientific ability with leanings either to music, or art, or poetry, is very common, and examples are to be found in almost every biography of men of science. It is difficult indeed to name an eminent scientific man who has not strong leanings towards some artistic recreation: we find the poetic vein in Maxwell and Sylvester, the musical talent in Helmholtz and Rayleigh, and the enthusiastic though amateurish pictorial efforts of less important men. That the similarities are to be found also in temperament may be noticed on reading Arnold Bennett's article on "The Artist and the Public,"[9] where many passages will be seen to be applicable to students of science as well as to writers of fiction.

If we look for distinctions between different individuals, we may find one in their leanings either towards the larger aspects of a question or the microscopic study of detail. The power of focusing simultaneously the wider view and the minute observation is perhaps the most characteristic attribute of those who reach the highest eminence in any profession, but the great majority of men have a notable predilection for the one or other side. Though it is indispensable for a scientific man to study the details of the particular problem he is trying to solve, there are many who will lose interest in it as soon as they believe they can see a clear way through the difficulties without following up their solution to its utmost limits. To them detail, as such, has no interest, and they will open and shut a door a hundred times a day without being even tempted to inquire into the inner working of the lock and latch.

There is only one feature in the operation of the intelligence by means of which a sharp division may possibly be drawn between brain-workers showing special capabilities in different subjects. In some persons thought attaches itself mainly to language, in others to visualized images, and herein lies perhaps the distinction between the literary and scientific gift. Those who, owing to external circumstances, have resided in different countries are sometimes asked in what language they think. Speaking for myself, I have always been obliged to answer that, so far as I can tell, thought is not connected with any language at all. The planning of an experiment or even the critical examination of a theory is to me entirely a matter of mental imagery, and hence the experience, which I think many scientific men must have shared, that the conversion of thought into language, which is necessary when we wish to communicate its results to others, presents not only the ordinary difficulties of translation but reveals faults in the perfection or sequence of the images. Only when the logic of words finally coincides with the logic of images do we attain that feeling of confidence which makes us certain that our results are correct.

A more detailed examination of the instinctive predilections of a child would, I think, confirm Poincaré's conclusion that a decided preference for one subject is in the main due to an unconscious appeal to his emotions. It should be remembered, however, that the second step of Poincaré's philosophy is as important as the first. The mere emotional impulse would die out quickly, if it were not supplemented by the gratification experienced on discovering that the search for the beautiful leads us

[9] *English Review*, October, 1913.

to results which satisfy our intellect as well as our emotions. There may still be bifurcations in the second portion of the road. Some may rest content with achieving something that supplies the material needs of humanity, others may be inspired to search for the deeper meaning of our existence.

There remains therefore some justification for the question why we persist in studying science apart from the mere intellectual pleasure it gives us. It was once a popular fallacy to assume that the laws of nature constituted an explanation of the phenomena to which they applied, and people then attached importance to the belief that we could gauge the mind of the Creator by means of the laws which govern the material world, just as we might trace the purpose of a human legislator in an act of parliament. As this archaic interpretation was abandoned, philosophers went, in accordance with what politicians call the swing of the pendulum, to the other extreme. We can explain nothing, they said—in fact, we can know nothing—all we can do is to record facts. This modesty was impressive and it became popular. I know, at any rate, one scientific man who has acquired a great reputation for wisdom by repeating sufficiently often that he knows nothing, and, though his judgment may be true, this frame of mind is not inspiring. As a corrective to the older visionary claims, which centered round the meaning of the word "explain," the view that the first task of science is to record facts has no doubt had a good influence. Kirchhoff laid it down definitely that the object of science is to describe nature, but he did not thereby mean that it should be confined to recording detached observations: this would be the dullest and most unscientific procedure. Description, in the sense in which Kirchhoff uses it, consists in forming a comprehensive statement gathering together what, till then, was only a disconnected jumble of facts. Thus the apparently quite irregular motions of the planets, as observed from the earth, were first collected in tabular form. This was a necessary preliminary but was not in itself a scientific investigation. Next came Kepler, who by means of three laws summed up the facts in their main outlines, and the description then took a more refined form, substituting half a page of printing for volumes of observations. Finally, Newton succeeded in predicting the planetary movements on the assumption of a gravitational attraction between all elements of matter. According to Kirchhoff, the chief merit of this discovery would lie in its condensing Kepler's three laws into one hypothesis. This point of view is not necessarily opposed to that of Poincaré, because it is exactly the simplicity of Newton's explanation that appeals most strongly to our esthetic sense, but there is an important difference in the manner of expression. However beautiful an idea may be, it loses its effect by being placed before us in an unattractive form. This criticism also applies to Mach, according to whom the object of science is to economize thought, just as it is the object of a machine to economize effort. Logically, this definition is justified and it may be the best that can be given, if we prefer using a technical expression to confessing an emotional feeling. But why should we do so? Is it not better to recognize that human intelligence is affected by sentiment as much as by reasoning? It is a mistake for scientific men to dissociate themselves from the rest of humanity, by placing their motives on a different and, at the best, only superficially higher, level. When an adventurous spirit, for instance, desires to organize an expedition to unknown regions of the world, we try to induce our governments

to provide the necessary funds by persuading them, and incidentally ourselves, that we do so because important scientific results may be expected from the expedition. This may actually be the case, but we are mainly affected by the same motives as the rest of the community: if the truth be told, we are as curious as they to know what every corner of the earth looks like, and we join them in wishing to encourage an enterprise requiring perseverance and involving danger.

I fully realize that the wish to justify one's own work in the eyes of the world will always lead to fresh attempts to find a formula expressing the objects which we desire to attain. Enough, however, has been said to show that the definition must take account of sentiment, without insisting too much upon it. Nor can we hope, in view of the variety of intellectual and emotional pleasures which combine to create the charm of science, to include all points of view, but if I were forced to make a choice I should say that the object of science is to predict the future. The wish to know what lies before us is one of the oldest and most enduring desires of human nature; often, no doubt, it has degenerated and given rise to perverted and ignoble longings, but its accomplishment, when it can be achieved by legitimate inquiry, is a source of the purest and most satisfying enjoyment that science can give. We feel that enjoyment each time we repeat an old and perhaps hackneyed experiment. The result is known beforehand, but be it only that we expect the color of a chemical precipitate to be green or yellow, be it only that we expect a spot of light to move to the right or left, there is always a little tremor of excitement at the critical moment and a satisfying feeling of pleasure when our expectation has been realized. That pleasure is, I think, enhanced when the experiment is not of our own making but takes place uncontrolled by human power. In one of Heine's little verses he makes light of the tears of a young lady who is moved by the setting sun. "Be of good cheer," the poet consoles her, "this is only the ordinary succession of events: the sun sets in the evening and rises in the morning." If Heine had been a man of science, he would have known that the lady's tears found a higher justification in the thought of the immutable and inexorable regularity of the sun's rising and setting than in the fugitive color impression of his descent below the horizon, and that her emotions ought to be intensified rather than allayed by the thought of his resurrection in the morning—everybody's life contains a few unforgettable moments which at quite unexpected times, will vividly rise in his mind, and there are probably some in this hall who have experienced such moments at the beginning of a total eclipse of the sun. They have probably traveled far, and gone through months of preparation, for an event which only lasts a few minutes. The time of first contact is approaching, in a few seconds the moon is about to make its first incision in the solar disc, and now the observer's thoughts come crowding together. What if there were a mistake in our calculations? What if we had chosen a spot a few miles too far north or too far south? What if the laws of gravitation were ever so little at fault?—But now at the predicted time, at the calculated spot on the sun's edge, the dark moon becomes visible, and the feeling of relief experienced concentrates into one tense instant all the gratitude we owe those who have given precision to the predictions of celestial movements, leaving them expressible by a simple law which can be written down in two lines. It is this simplicity of the law of gravitation, and its accuracy which

some day may show limitations, but has hitherto withstood all tests, that gives to astronomy its preeminence over all sciences.

Indeed, if we classify the different sections into which science may be divided, I think it may be said that their aim, in so far as it is not purely utilitarian, is always either historic or prophetic; and to the mathematician, history is only prophecy pursued in the negative direction. It is no argument against my definition of the objects of science, that a large section of its sub-divisions has been, and to some extent still is mainly occupied with the discovery and classification of facts; because such classification can only be a first step, preparing the way for a correlation into which the element of time must enter, and which therefore ultimately must depend either on history or prophecy.

Latterly men of science, and in particular physicists, have given increased attention to the intrinsic meaning of the concepts by means of which we express the facts of nature. Everything—who can deny it?—is ultimately reduced to sense impressions, and it has therefore been asserted that science is the study of the mind rather than of the outside world, the very existence of which may be denied. The physicist has thus invaded the realm of philosophy and metaphysics, and even claims that kingdom as his own. Two effects of these efforts, a paralyzing pessimism and an obscure vagueness of expression, if not of thought, seriously threatened a few years ago to retard the healthy progress of the study of nature. If the outside world were only a dream, if we never could know what really lies behind it, the incentive which has moved those whose names stand out as landmarks in science is destroyed, and it is replaced by what? By a formula which only appeals to a few spirits entirely detached from the world in which they live. Metaphysicians and physicists will continue to look upon science from different points of view, and need not resent mutual criticisms of each other's methods or conclusions. For we must remember that most of the good that is done in this world is done by meddling with other people's affairs, and though the interference is always irritating and frequently futile, it proves after all that our interests converge towards a common center.

According to Poincaré, the pleasure which the study of science confers consists in its power of uniting the beautiful with the useful; but it would be wrong to adopt this formula as a definition of the object of science, because it applies with equal force to all human studies. I go further, and say that the combination of the search for the beautiful with the achievement of the useful is the common interest of science and humanity. Some of us may tend more in one direction, some in another, but there must always remain a feeling of imperfection and only partial satisfaction unless we can unite the two fundamental desires of human nature.

I have warned you at the beginning of this discourse not to beat the utilitarian drum too loudly, and I have laid stress throughout on the idealistic side, though the most compelling events of the moment seem to drive us in the other direction, and the near future will press the needs of material prosperity strongly upon us. I must guard myself, therefore, against one criticism which the trend of my remarks may invite. At times, when the struggle for existence keeps masses in permanent bondage, in a society in which a multitude of men and women have to face starvation, and when unfortunate, though purely accidental, surroundings in childhood drive the weak into misery, is it not futile to speak of esthetic motives? Am I not,

while endeavoring to find a common bond between all sections of the community, in reality drawing a ring round a small and privileged leisured class, telling them these enjoyments are for you and for you alone? Should I not have found a surer ground for the claims of science in its daily increasing necessity for the success of our manufactures and commerce?

I have said nothing to indicate that I do not put the highest value on this important function of science, which finds its noblest task in surrendering the richness of its achievements to the use of humanity. But I must ask you to reflect whether the achievement of wealth and power, to the exclusion of higher aims, can lead to more than a superficial prosperity which passes away, because it carries the virus of its own doom within it. Do we not find in the worship of material success the seed of the pernicious ambition which has maddened a nation, and plunged Europe into war? Is this contempt for all idealistic purposes not responsible for the mischievous doctrine that the power to possess confers the right to possess, and that possession is desirable in itself without regard to the use which is made of it? I must therefore insist that if we delight in enlisting the wealth accumulated in the earth, and all the power stored in the orbs of heaven, or in the orbits of atomic structure, it should not be because we place material wealth above intellectual enjoyment, but rather because we experience a double pleasure if the efforts of the mind contribute to the welfare of the nation. When Joule taught us to utilize the powers at our disposal to the best advantage he did it not—and his whole life is a proof of it—to increase either his own wealth or that of the nation, but because, brought up in commercial life and deeply imbued with the deep insight and genius of science, he found his greatest delight in that very combination of esthetic satisfaction and useful achievement which Poincaré has so well described. And again, when another of our fellow-citizens, Henry Wilde, showed how electrical power can be accumulated until it became an efficient instrument for the economic transmission of work, he found his inspiration in the intellectual gratification it gave him, rather than in the expectation of material gain. I am drawing no ring round a privileged class, but urge that the hunger for intellectual enjoyment is universal and everybody should be given the opportunity and leisure of appeasing it. The duty to work, the right to live, and the leisure to think are the three prime necessities of our existence, and when one of them fails we only live an incomplete life.

I should have no difficulty in illustrating by examples, drawn from personal experience, the power which the revelations of science can exert over a community steeped in the petty conflicts of ordinary life; but I must bring these remarks to a conclusion, and content myself with the account of one incident.

An American friend, who possessed a powerful telescope, one night received the visit of an ardent politician. It was the time of a presidential election, Bryan and Taft being the opposing candidates, and feeling ran high. After looking at clusters of stars and other celestial objects, and having received answers to his various questions the visitor turned to my friend:

And all these stars I see, he asked, what space in the heaven do they occupy?

About the area of the moon.

And you tell me that every one of them is a sun like our own?

Yes.

And that each of them may have a number of planets circulating round them like our sun?

Yes.

And that there may be life on each of these planets?

We can not tell that, but it is quite possible that there may be life on many of them.

And after pondering for some time, the politician rose and said: It does not matter after all whether Taft or Bryan gets in.

Happy were the times, when it could be said with truth that the strife of politics counted as nothing before the silent display of the heavens. Mightier issues are at stake to-day: in the struggle which convulses the world, all intellectual pursuits are vitally affected, and science gladly gives all the power she wields to the service of the state. Sorrowfully she covers her face because that power, accumulated through the peaceful efforts of the sons of all nations, was never meant for death and destruction; gladly she helps, because a war wantonly provoked threatens civilization, and only through victory shall we achieve a peace in which once more science can hold up her head, proud of her strength to preserve the intellectual freedom which is worth more than material prosperity, to defeat the spirit of evil that destroyed the sense of brotherhood among nations, and to spread the love of truth.

ARTHUR SCHUSTER

THE MIGRATIONS OF DISTINGUISHED AMERICANS

WHERE do great men go? Do they go anywhere? Are the recognized leaders of activity and thought in the class of "rank outsiders" or have they been born and brought up in the same spot which now marks the field of their labors?

These questions can not be answered finally for two reasons. In the first place, because there is no perfectly authentic record from which the names of all leaders may be gleaned, and second, because the available records are in many cases faulty. Nevertheless, the eighteen thousand names listed by "Who's Who in America" contains a large proportion of the leading men of the country, and even though the list does contain the names of many who are not recognized leaders, it is, on the whole, an excellent weathervane for America's great and near-great in the mass.

Among other suggestive facts, "Who's Who"[1] tells for each person whose biography appears, the place of birth and the present address. By comparing the two, for a large number of cases, the facts regarding the movements of great men may be ascertained.

A study of "Who's Who" shows two distinct movements, one from the east and south to the north and west; the other from the country district and the small town to the great city. The great men born in the east and south have gone west in large numbers. At the same time, many of the leaders in city life came from outside the city.

The movement of great men from the east to the west is strikingly apparent. Among 16,449 distinguished persons whose names appear in "Who's Who," over nine-tenths (91.6 per cent.) were born in the New England, Middle Atlantic states, the East North Central, South Atlantic and East South Central states. This division includes roughly the territory east of the Mississippi River. Although only one twelfth of the distinguished persons were born west of this division line, at the present time, one sixth (16.8 per cent.) resides there. The migrations from the Eastern states have been felt most heavily in New England and in the East North Central states. Among the persons listed in "Who's Who," 3,764 (22.9 per cent.) were born in New England—2,921 (16.2 per cent.) now live there; 3,609 (22.0 per cent.) were born in the East North Central states—2,919 (16.2 per cent.)

[1] "Who's Who" is published in Chicago. The editor, Albert Nelson Marquis, was born in Ohio. "The standards of admission to 'Who's Who in America' divide the eligibles into two classes: (1) Those who are selected on account of special prominence in creditable lines of effort, making them the subjects of extensive interest, inquiry or discussion in this country; and (2) those who are arbitrarily included on account of official position—civil, military, naval, religious or educational—or their connection with the most exclusive learned or other societies." From a statement following the preface, 1912–13 edition.

now reside there. The gains have been most notable in the Mountain and Pacific states. Among the persons listed in "Who's Who," 48 (.3 per cent.) were born in the Mountain states—466 (2.5 per cent.) now reside there; 207 (1.2 per cent.) were born in the Pacific states—865 (4.8 per cent.) now reside there. Apparently the northeastern section of the United States has lost heavily in favor of the extreme western portion of the country. Although producing a negligible portion of the total distinguished persons, the western states are gaining considerably through the migration of distinguished persons from their birthplace.

An excellent corroboration of this appears from a study of specific states. Among the Eastern states, Massachusetts, New York, New Jersey and Illinois alone have more distinguished persons now resident than were born in them. At the same time, Minnesota and Florida have a resident population of distinguished persons larger than the number born there. With the exception of Florida and the District of Columbia, these states are western and southwestern states. The opposite condition appears if a list is made of those states in which fewer distinguished persons are resident than the number born. In this list appear Maine, New Hampshire, Rhode Island, Connecticut, Vermont, Pennsylvania, Ohio, Indiana, Michigan, Wisconsin and Iowa together with eleven of the southern and east south central states.

The total number of persons native born in the states having more distinguished persons now resident than were born in them was 7,302; the total number now resident in these same states is 12,058. The total number of persons born in the other group of states was 9,119; and the total number now resident is 6,042.

A similar result may be arrived at by making a table showing the number of states in which the resident distinguished persons are larger or smaller than the number native born distinguished persons.

If the statistics are carried out in the form of ratios, it appears that there were 12 states in which the ratio of distinguished now resident to distinguished born persons was less than 74 per hundred. All of the states with the exception of Wisconsin were in the eastern and northeastern parts of the United States. At the same time, there were 19 states in which the ratio of distinguished persons now resident to distinguished persons native born was over 175 per hundred. Every one of these states, except Florida, was west of the Mississippi.

A CLASSIFICATION SHOWING THE NUMBERS OF STATES IN WHICH THE NUMBER OF RESIDENT DISTINGUISHED PERSONS WAS LARGER AND IN WHICH THE NUMBER WAS SMALLER THAN THE NUMBER BORN IN THOSE STATES, CLASSIFIED BY GEOGRAPHICAL DIVISIONS

Division	Number of States in Which Number of Resident Distinguished Persons is Larger	Smaller
United States		
New England	1	5
Middle Atlantic	2	1
East North Central	1	4
West North Central	6	1
South Atlantic	2	7
East South Central	0	4
West South Central	4	0
Mountain	8	0
Pacific	3	0

There seems to be no question but that the great men of the present generation have been moving steadily westward. The older parts of the country produced them, but they have persistently found their way into the newer parts. Some critics will contend that this is merely another way of saying that the opportunities of the new territory brought out the latent abilities of those who went there. While such a view may have some justification, the fact can not be lost sight of that while the west was gaining so persistently, the east was as steadily losing.

The facts regarding the movement into the cities are less conclusive, but none the less significant.

Of the four northeastern states showing a larger number of distinguished persons now resident than the number native born were

Massachusetts, New York and Illinois. In each of these states is at least one great city center of commerce and industry. Had this fact any influence upon the position of these three states? In order to answer this question, the consecutive names of 2,000 native-born persons were taken at random.[3] Among this 2,000, 549 were born in cities of more than 100,000 population, and 1,365 are now resident in these cities. The figures for New York, Chicago, Philadelphia, Boston and Washington show 317 born in these cities, and 791 now resident. The figures for New York, Philadelphia, St. Louis, San Francisco, Washington, Baltimore and Chicago show 355 born and 851 now resident. The proportion absorbed by the larger cities is not, on the whole, greater than the proportion absorbed by urban as opposed to rural life.

One thing the figures show conclusively, that there has been a marked movement of distinguished persons from the northeastern section of the United States to that section west of the Mississippi and particularly that section included in the Pacific and Mountain states. City life is in no large sense responsible for this movement. It is evidently a logical reaction to the wide range of opportunity which the west affords.

SCOTT NEARING

SCIENTIFIC NOTES AND NEWS

DR. MAX PLANCK, professor of physics at Berlin, and Professor Hugo von Seeliger, director of the Munich Observatory, have been made knights of the Prussian order pour le mérite. Dr. Ramón y Cajal, professor of histology at Madrid, and Dr. C. J. Kapteyn, professor of astronomy at Gröningen, have been appointed foreign knights of this order.

M. GEORGES VAN BIESBROECK, Dr. Ing., adjunct astronomer at the Royal Observatory of Belgium, situated at Uccle, has joined the staff of the Yerkes Observatory, University of Chicago, for the academic year 1915–16, with the title of visiting professor of practical astronomy. His work will be chiefly devoted to double stars and to the regular program of determining stellar parallaxes from photographs made with the 40-inch refractor.

[3] They started with L. F. Merrifield, and ended with H. W. Ranger.

THE second Pan-American Scientific Congress, which will meet in Washington, December 27, 1915, and adjourn January 8, 1916, will be divided into nine sections, which, with their chairmen, are as follows: Anthropology, William H. Holmes; Astronomy, Meteorology and Seismology, Robert S. Woodward; Conservation of Natural Resources, George M. Rommel; Education, P. P. Claxton; Engineering, W. H. Bixby; International Law, Public Law and Jurisprudence, James Brown Scott; Mining and Metallurgy, Economic Geology and Applied Chemistry, Hennen Jennings; Public Health and Medical Sciences, William C. Gorgas; Transportation, Commerce, Finance and Taxation, L. S. Rowe.

DR. THEOBALD SMITH, head of the division of comparative pathology of the Rockefeller Institute for Medical Research, should be addressed at Princeton, N. J., after October 1.

DR. RICHARD PEARSON STRONG is returning to this country from Servia to resume his position as professor of tropical medicine in Harvard Medical School.

DR. SEISHU KENOSHITA, professor of gynecology and obstetrics in the Imperial University, Tokyo, Japan, has been designated by the government to make an extensive tour and study of American hospitals.

NEWS has been received of the safe return of Vilhjalmar Steffanson, who has been conducting a Canadian expedition to the far north. He expects to spend two more years in exploration.

DR. STOCK, professor of chemistry at Munich, has been appointed a member of the Kaiser Wilhelm Institute for Chemistry at Dahlem.

DR. ELISHA H. COHOON has been appointed administrative head of the psychopathic department of the Massachusetts State Hospital, at Boston. Dr. E. E. Southard, who has been director of the institution for a number of years, will be relieved of his administrative duties, but will retain the title of director and

will have charge of the scientific research laboratories of the hospital.

DR. THOMAS B. SHEA, Boston, has been appointed chief of the medical division of the department of health. Dr. H. Mulloney, formerly a member of the Boston Board of Health, has been appointed a deputy health commissioner. Dr. Francis H. Slack, formerly secretary of the board of health, has been made deputy in the bacteriologic department.

F. L. DRAYTON has been appointed assistant botanist at the Canadian Experimental Farms, and George W. Muir, assistant animal husbandman at the Nova Scotia Agricultural College. J. A. Sinclair has succeeded J. Standish in the veterinary department, and C. A. Good has been appointed assistant entomologist.

DR. FRIEDRICH HILDEBRANDT, formerly professor of botany at Freiburg, has celebrated his eightieth birthday.

THE Weber-Parkes prize of the Royal College of Physicians for 1915 has been awarded to Dr. Noel Dean Bardswell.

A. MÜLLER, of Berlin, who has perfected the accumulator used in submarine boats, has been made doctor of engineering by the Technical School of Hanover.

A BRONZE bust of the late Dr. S. Weir Mitchell has been presented by Mr. and Mrs. Walter D. Ladd to the Jesup Memorial Library in Bar Harbor.

DR. EDWARD NELSON TOBEY, of St. Louis, was a passenger on the fruit steamer *Marowijne*, which has not been heard from since August 13, and is believed to have been wrecked by a hurricane in the Gulf of Mexico or the Caribbean Sea on that date. Dr. Tobey was one of the medical party sent by the St. Louis University to British Honduras at the beginning of the summer. He was a lecturer in the medical department of the university and an assistant city bacteriologist.

CHARLES HALLET WING died on September 13 in his eightieth year. He was born in Boston and was graduated from Harvard College. In 1870 he became professor of chemistry at Cornell University, from which place he went in 1874 to Boston to accept a like position at the Massachusetts Institute of Technology, where he remained for ten years.

JOHN E. SINCLAIR, professor emeritus of higher mathematics at the Worcester Polytechnic Institute, died on September 12. He was born in 1838 and attended the Exeter Latin School and later the Chandler School at Dartmouth College. After he was graduated he went to Adrian, Mich., to teach, and later to St. Louis, Mo. In 1863 he returned to Dartmouth as professor of mathematics and was awarded the degree of Ph.D. there. In 1869 he went to Worcester Polytechnic Institute as professor of higher mathematics, from which position he retired six years ago as professor emeritus.

PROFESSOR B. FISCHER, director of the hygienic laboratory of the University of Kiel, has died in one of the military hospitals at the age of sixty-three years.

PROFESSOR M. ROTHMANN, of Berlin, died on August 12, aged forty-seven years. He is known for his work on the localization of brain functions and was responsible for the establishment of the anthropoid station in Teneriffe.

G. CATTANEO, for half a century professor of surgery at the University of Pavia, has died at the age of eighty-three years. He bequeathed most of his property to found an institution there for treatment of the maimed and crippled.

As a piece of constructive work in conservation, the New York State College of Forestry, at Syracuse, has begun this summer an ecological survey of Oneida Lake. Special attention will be given to the fishes. Oneida Lake has an area of 81 square miles, a maximum depth of 55 feet, a length of 21 miles and an average width of about 6 miles. It has a large area of shallow water, is bordered by extensive swamps, abounds in fish, and a state fish hatchery is located on it at Constantia. Mr. Frank C. Baker, recently acting director of the Chicago Academy of Science, a well-known specialist on molluscs, will study the relation of molluscs to the feeding and breed-

ing grounds of fish, and Professor T. L. Hankinson, of the Eastern Illinois Normal School, Charleston, Ill., will with Dr. Charles C. Adams, of the College of Forestry, investigate the ecology of the fish.

A cooperative plan for the study of the underground waters in the southeastern corner of Montana under an area of about ten thousand square miles has been arranged by O. E. Meizner representing the U. S. Geological Survey, with the chemical department of the Montana State College and the chemical laboratory at the college which does the work for the Montana board of health. Under the arrangement the field work will be done by the geological survey and the analyses amounting to about two hundred will be done by the State College and the board of health under the direction of Professor W. M. Cobleigh. The work is to be completed by July 1, 1916. The study deals with the mineral content of the waters only and is of importance both to the agricultural interests of the state and to the public health as affecting the matter of domestic water supply.

Dr. Lucy L. W. Wilson, head of the department of nature study and geography of the Philadelphia Normal School, excavated this summer at the prehistoric site called Otowi, New Mexico, for the Philadelphia Commercial Museums, of which her husband, Dr. W. P. Wilson, is the director. She has returned with a fine collection of prehistoric pottery including a dozen unbroken bowls, about thirty bowls of which all of the pieces have been secured, and forty pieces of pottery of which at least half is intact. Every type of pottery is represented, including even a small piece of very ancient basket ware, a whole bowl of incised ware, some coiled ware, plenty of the biscuit, the hard "black and white," and the glazed patterns. Many clay food bowls, ollas, tinajes, ceremonial bowls and ceremonial pipes were found. A potter's outfit was dug out, consisting of balls of red and white clay, mica clay (for cooking pots), smoothing stones, shaping stones and paint pots. A great quantity of stone ware was excavated, much of which has been left *in situ*, although a good collection of domestic and hunting utensils and implements has been shipped to the museum. Over fifty skeletons were disinterred, but all except fifteen were reburied, chiefly because they were not in good condition. The most important find was a "basket-burial" in a room underneath the floor. On the body were many ceremonial objects—two rain sticks and about a dozen prayer sticks. The feet were in a glazed bowl. The mouth was full of corn and cobs of corn were on the face, the neck, the chest. A dozen ceremonial pipes and a small copper pendant were found in the same room. Another unusual burial was that of a child in a bowl with a couple of clay playthings near by. Most of the adults were buried in the usual reflexed position with the face toward the west. Two skeletons, however, were found face down. One of these had a long ceremonial pipe of serpentine in his mouth.

We learn from *Nature* that the Royal Society is compiling a register of scientific and technical men in Great Britain and Ireland, who are willing to give their services in connection with the war. The register will be classified into subjects, and will ultimately constitute a large panel of men of standing, whose services will be available whenever any government department or similar authority requires specialist assistance. The register is being coordinated with those independently compiled by other societies and institutions, but the Royal Society would be glad to have applications for forms from such members of the staffs of colleges and technical institutions as have not yet been registered by any society. The Royal Society is also drawing up, with the cooperation of the principal societies and institutions, a list of scientific and technical men actually on active service in the army and navy.

The medical secretary of the British Medical Association has made a report on the medical war register and the work hitherto done by the committee, according to which the physicians in England, Wales and Ireland are distributed as follows:

1. The number of men already on whole-time war service (total, 5,265).

2. The number of men of 50 years of age and over offering whole-time war service (total, 447).

3. The number of men from 40 to 49 offering whole-time war service (total, 436).

4. The number of men of 40 and under offering whole-time war service (total, 633).

5. The number of men of 40 and under not on whole-time war service, nor offering to undertake it (total, 6,555 up to date).

From these figures it will be seen that there are approximately 6,555 men of military age not at present engaged in war service; of these the services of about one third are said to be needed.

THE Berlin correspondent of the *Journal* of the American Medical Association reports that the Kaiser Wilhelm Institute for the Study of the Physiology and Pathology of the Workingman has now begun its work. Researches will be made in the physiology, pathology and hygiene of labor (work), the mental and physical welfare of the workingman. The relationship of labor to the age of the workingman, the sex, the race, nourishment, environment, clothing, etc., will be investigated. The physiologic chemistry department will investigate particularly the physiology of nutrition in order to determine the influence of food on the working capacity of the workingman and the influence of alcohol on muscle energy. The statistical division will approach the question from another point of view including a study of food and food elements, animal as well as vegetable, the size of a family as bearing on the nutrition, the difference in eating in the city and in the country among the poor and among the rich. The psychologic division will investigate the influence of labor in its relationship to psychathenia, etc. The work done by others in similar fields will place these studies on a definite basis. The well-known Taylor system has done much to further these studies; for instance, it is known that severe physical labor causes the blood to leave the viscera and appear in increased quantity in the extremities. Physical tire, on the other hand, produces the opposite. Therefore deleterious effects may be prevented by regulating the work either by frequent periods of rest or by changing the kind of work so that other muscle groups may be brought into play. It is the aim of the institute to investigate all the phases of this question thoroughly so that the results may prove beneficial to the workingman as well as to his employer. Tuberculosis will come in for a large share of study, especially with regard to the etiologic relationship of poor housing conditions in the cause and spread of tuberculosis. The alcohol question, female and child labor, etc., will be investigated.

THE finest and most accurate maps of the United States are those made by the United States Geological Survey. This branch of the government service prints more than 3,000 maps a day, or about a million a year, most of which are sold to the public directly from Washington. Book and stationery concerns in the larger cities of course handle these maps, but heretofore there has been no way in which the inhabitants of the small towns throughout the country could get them except by sending to Washington. Now, however, postmasters in towns and villages have the permission of the Post Office Department to handle these maps. When the Geological Survey prints a new map it sends a sample copy to the postmasters in the area covered, with the suggestion that they tack it up in a conspicuous place, where everyone calling for mail can see it, and order a small stock for sale to those who wish to buy the map. This saves the purchaser the annoyance of sending to the Geological Survey and waiting until the map is received from Washington and also saves the expense of postage. The postmaster himself receives a small commission on each map sold. Many active postmasters are handling the maps, and that their fellow-citizens appreciate the accommodation of being able to buy government maps at the post office is shown by the number sold in this way. The record of maps so sold shows that a postmaster in Minnesota heads the list so far, having sold 125 maps the first month he handled them. Only postmasters in regions that have been recently mapped have been asked to handle the maps,

but the Geological Survey willingly answers inquiries made by other postmasters, sending them a sample copy of the map that covers their district, if it has been mapped. It is believed that this new plan of distributing the government maps will benefit all concerned; it will be a convenience to the purchasers, it will bring the postmasters a small commission, and it will increase the sale of the maps.

THE registrar-general for England and Wales has issued his return relating to the births and deaths in the second quarter of the year, and to the marriages in the three months ending March last. From a report in the *British Medical Journal* we learn that the marriage-rate during that period was equal to 12.0 per 1,000, which was 0.8 per 1,000 more than the mean rate in the corresponding periods of the ten preceding years. The 213,094 births registered in England and Wales last quarter were equal to an annual rate of 22.9 per 1,000 of the population, estimated at 37,302,983 persons. This rate is 3.3 per 1,000 below the mean rate in the ten preceding second quarters, and is the lowest rate recorded in the second quarter of any year since civil registration was established. The birth-rates in the several counties last quarter ranged from 16.0 in Sussex, 17.0 in Somerset, 17.1 in Westmorland and 17.3 in Cardigan, to 27.2 in Stafford, 27.3 in Carmarthen, 27.5 in Northumberland, 28.3 in Glamorgan, 28.5 in Monmouth and 30.8 in Durham. The excess of births over deaths last quarter was only 74,515, against 102,293, 105,727 and 101,933 in the second quarters of the three preceding years. From a return issued by the board of trade it appears that between the United Kingdom and places out of Europe the arrivals of persons stated to be of British nationality exceeded the departure by 8,583 persons, while the numbers of aliens leaving exceeded those arriving by 431. The balance of the aggregate passenger movement in the quarter to and from all countries was 6,580 inward. The 138,579 deaths registered in England and Wales during the quarter under notice were equal to an annual rate of 14.9 per 1,000, against an average rate of 13.7 per 1,000 in the corresponding quarter of the ten preceding years. The death-rates in the several counties last quarter ranged from 11.2 in Middlesex, 12.0 in Essex and in Rutland, 12.4 in Berkshire, and 12.5 in Buckinghamshire and in Dorset, to 17.2 in Cumberland, 17.3 in Montgomery, 17.7 in Durham, 17.8 in Denbigh, 18.3 in the North Riding of Yorkshire and 18.4 in Cardigan. The 138,579 deaths from all causes last quarter included 311 which were attributed to enteric fever, 6 to smallpox, 6,724 to measles, 590 to scarlet fever, 2,589 to whooping-cough, 1,176 to diphtheria and 1,496 to diarrhea and enteritis among children under 2 years of age. The mortality from measles was nearly double the average, and that from diphtheria was slightly above the average; from scarlet fever and whooping-cough the mortality was slightly below the average, and that from enteric was 40 per cent. below. The rate of infant mortality, measured by the proportion of deaths among children under 1 year of age to registered births, was equal to 97 per 1,000, which was 2 per 1,000 above the mean rate in the ten preceding second quarters.

STATISTICS compiled under the supervision of J. D. Northrop, of the United States Geological Survey, show that the quantity of natural gas commercially utilized in the United States in 1914 exceeded that so utilized in any previous year in the history of the natural gas industry. The quantity produced, which amounted to approximately 591,866,733,000 cubic feet, valued at $94,115,524, constitutes a new record of production exceeding by nearly 10 billion cubic feet, or almost 2 per cent., the former record, established in 1913. Increases in output in 1914 over 1913 were credited to New York, Ohio, Oklahoma, Texas, Louisiana-Alabama, Iowa and California, the state last named alone recording a gain of nearly 7 billion cubic feet. Other gas-producing states recorded declines in output the greatest of which, that of Pennsylvania, amounting to slightly more than 10 billion cubic feet. The increases in gas production may be attributed to various causes—in New York to the in-

creased drilling activity stimulated by the advancing petroleum market in 1913 and the early part of 1914; in Ohio to local extensions of the productive fields of the gas belt in the central part of the state and to the development of an important gas pool in the vicinity of Cleveland, Cuyahoga County; in Oklahoma to the development of gas reserves in the Cushing field, Creek County, and the Healdton field, Carter County, as well as to a decided expansion of the local casinghead gasoline industry; in Texas to a greater utilization of the gas supplies available in the Petrolia and Mexia fields; in Louisiana to the greater development of the gas reserves in Caddo and De Soto parishes, and in California to increased demands for domestic consumption in Los Angeles and adjacent towns in the southern part of the state as well as for industrial consumption in the casinghead gasoline industry. Of the record-breaking production of natural gas credited to 1914 it is estimated that the total of 203,104,358,000 cubic feet, about 34 per cent., was supplied to domestic consumers at an average price of 28.04 cents a thousand cubic feet and that 388,762,375,000 cubic feet, the remaining 66 per cent., was supplied to industrial consumers at an average price of 9.56 cents a thousand cubic feet. During the last four years the ratio of domestic to industrial consumption has varied but slightly. Formerly, however, a relatively greater proportion of the annual yield was supplied to industrial consumers.

The Alaskan Engineering Commission, which is to build the government railroad from Seward on the Pacific 471 miles to Fairbanks in the interior, has received a permit from the Forest Service to cut 85 million feet of timber in the Chugach National Forest for use in constructing the new line. The permit was issued by the district forester at Portland, Oregon, who has direct supervision of the Alaskan forests, and is in conformity with the Act of March 4, last, which authorized the Secretary of Agriculture to permit the Alaskan Engineering Commission and the Navy Department to take from the national forests free of charge earth, stone and timber for use in government works. The timber will be cut in designated areas along the right-of-way of the proposed railroad, which runs through the Chugach National Forest for several miles. Experiments and tests of Alaskan spruce and hemlock are being made at the Forest Service Laboratory at Seattle, Washington, and so far have substantiated the opinion of foresters that Alaskan timber is sufficiently strong for practically all structural purposes. While these tests are going on Forest Service employees in Alaska are marking the timber to be cut along the proposed railroad, the cutting to be done so that only mature trees are taken, the young trees being left uninjured and the condition of the forest improved. This cut of 85 million feet will be the largest amount of timber ever felled on the Alaskan forests in one operation, and at the average rate per thousand board feet obtained for timber sold from the Chugach forest during the fiscal year 1914, it is worth approximately $145,000 on the stump. It will be nearly twice as much as the total quantity of national forest timber now cut and used annually for local purposes throughout Alaska, but only a little more than one tenth of the estimated annual growth of the Alaskan forests. The two national forests of Alaska contain about 78 billion feet of merchantable timber and it is estimated by the Forest Service that more than 800 million feet could be cut every year forever without lessening the forests' productivity.

The output of bituminous coal in the United States for the first six months of 1915 is estimated by C. E. Lesher, of the United States Geological Survey, to be between 180,000,000 and 190,000,000 short tons, the rate of production having been from 85 to 90 per cent. of the average for the previous year. Thus the bituminous coal production during this six-months' period has been considerably less than for the corresponding period in 1914, and is little, if any, greater than the output during the last half of that year. The rate of production this year decreased after January,

reached low ebb in March and April, and is now on the increase. The states west of Mississippi River, which in 1914 produced less than 13 per cent. of the total, do not appear to have suffered from this decrease as much as the eastern states—reports from certain districts in the west showing an increase over 1914. This is attributed to the increase in metal mining and smelting, and to greater railroad activity. In the east the loss of bunker trade on the Atlantic seaboard and the slowness of the Lake season have been only partly offset by the increasing coal exports. The recent activity in the iron business has been slow to affect the coal trade, although coke has gained considerably during the last two months and for the rest of 1915 the increased output should continue. The anthracite producers have fared better than the soft coal operators, since it is estimated that the output of anthracite has fallen off only from 3 to 5 per cent. below the average for 1914.

THE portion of the National Forest receipts for the fiscal year 1915 to go to the benefit of the various states in which the forests lie, according to the computation of the forest service just approved by the secretary of the treasury, amounts all told to more than $850,000. The gross receipts for the year ending June 30 were $2,481,469.35, of which under the law 25 per cent. is paid over to the states for county school and road purposes and an additional 10 per cent. is made available for expenditure by the secretary of agriculture in building road and trails for the benefit of local communities. Montana gets the largest share, having contributed the largest amount of receipts for the sale of timber, grazing and other uses of the forests, or more than $318,000. Of this amount, Montana is to receive $79,589.78 for county school and road purposes, while the forest service will expend $31,835.91 for improvements of special benefit to local communities and not included in the regular administrative and protective improvements. Idaho comes second with a 25 per cent. allowance of $75,651.15 and a 10 per cent. fund of $30,260.46. California is third, receiving a 25 per cent. allowance of $67,611.87 and a 10 per cent. fund of $27,044.74. The total amount to be expended under this system of sharing the forest receipts with the states to make up for the loss of local taxes due to public ownership of the land is about $16,000 greater than for the previous fiscal year, as the receipts for the fiscal year 1915 exceeded those of the previous fiscal year by about $44,000. The provision of law under which a portion of the receipts is turned over to the states dates from 1906, and the total payments reach, with this year's allotment, nearly $4,500,000. The ten per cent. provision for government-built public roads has been in force only since 1912, and has now made available for this purpose an aggregate of $926,000.

UNIVERSITY AND EDUCATIONAL NEWS

THE Southern Methodist University, Dallas, Texas, begins its initial session September 22. This is a coeducational institution under the auspices of the Methodist Episcopal Church South. The assets of the university in grounds, buildings and endowment amount to about one million and seven hundred thousand dollars. This university is to become the head of the southern Methodist colleges west of the Mississippi River. An active campaign is now being waged for an additional million dollars. The following appointments have been made on the scientific staff: Robert S. Hyer, A.M., LL.D., professor of physics; Frederick M. Duncan, Ph.D., professor of biology; John Henry Reedy, Ph.D. (Yale), professor of chemistry; Ellis W. Shuler, Ph.D. (Harvard), associate professor of geology.

PLANS have been approved by the board of regents of the University of Nebraska for a new hospital in connection with the College of Medicine at Omaha. The building is to be five stories in height and will have six wards of sixteen beds each, three receiving rooms, six groups of isolation rooms of three beds each, and the necessary operating rooms, operating amphitheater, and rooms for administration and service.

AT the sixty-third annual meeting of the American Pharmaceutical Association, which was held in San Francisco during the week of June 9, the president of the association, Mr. Caswell A. Mayo, of New York, announced that Mr. Samuel W. Fairchild had agreed to provide funds for a scholarship in pharmacy paying $300 annually, to be awarded to an undergraduate student by a commission composed of the presidents of the American Pharmaceutical Association, the American Conference of Pharmaceutical Faculties, the National Association of Boards of Pharmacy, and the editor of the *Journal of the American Pharmaceutical Association.*

Two new foundations are announced at Leeds University—the William Walker scholarship, of the annual value of £90, for the scientific study of leather with a view to its subsequent application to industrial development, and the William Walker Exhibition, for instruction in the technology of coal and its by-products. The new endowments are founded in memory of the late Mr. William Walker, of Whitehaven, by his widow and his sons, Mr. Herbert W. Walker and Mr. Arthur Walker. Both are primarily tenable at Leeds by inhabitants of the Whitehaven and Bootle districts, and the donors have placed £4,500 in trust for the purpose.

PROFESSOR IVEY F. LEWIS, of the University of Missouri, has become Miller professor of biology and head of the school of biology at the University of Virginia.

AT the Montana State College, R. H. Bogue, formerly at the Massachusetts Agricultural College, has been appointed assistant professor of chemistry and geology; Henry M. Shea, formerly of the South Dakota State College, analyst of the food and drug laboratory, and H. B. Foote, formerly of Oklahoma, instructor in botany.

DR. PAUL H. DIKE has been appointed professor of physics in Robert College, Constantinople, to succeed Professor Manning, who died last year. He sailed on the Greek line to Piraeus on September 15 with his family, together with a number of the members of the faculty of Robert College. The college is to open in spite of the war, and it is hoped that the party will be able to get through without much delay. The women and children will await developments in Athens.

DISCUSSION AND CORRESPONDENCE

THE LAWS OF MOTION

How well some of us remember and how much some of us have heard of the days of Thomson and Tait, and how satisfied we were and are with what Thomson and Tait had to say on this subject! In those days scarcely any one understood the laws of motion, but nowadays, thanks largely to the influence of Thomson and Tait, the chief confusion is that which rises from slightly different points of view, mostly correct; and the laws of motion now constitute the topic in the discussion of which one pays the least attention to what others say, and quite properly so.

We do, however, believe that it is misleading to speak of *the* fundamental equation of dynamics. Given three bodies A, B and C, and three identifiable forces a, b and c. Let the acceleration of each body due to each force be observed, and let the results be as shown in the accompanying table.

TABLE OF OBSERVED ACCELERATIONS

		Bodies		
		A	B	C
Forces	a	25	30	35
	b	50	60	70
	c	75	90	105

The acceleration varies from body to body for a given force, and from force to force for a given body. These are two equally fundamental modes of variation, and corresponding to them we have two equally fundamental laws of variation; and these laws of variation are entirely independent of the measurement of force and mass. Let us suppose that the above table has been extended so as to include a great many different forces and a great many different bodies, then a careful inspection of

the table would lead to the following generalizations.

(*a*) If one force produces twice as much acceleration as another force when acting on a given body, then the one force produces twice as much acceleration as the other force when acting on any body whatever.

(*b*) If one body is accelerated twice as much as another body under the action of a given force, then the one body is accelerated twice as much as the other body under the action of any force whatever.

The experimental fact (*a*) makes it convenient to define the ratio of two forces as the ratio of the accelerations they produce when acting on a given body, because this ratio is the same for all bodies.

The experimental fact (*b*) makes it convenient to define the ratio of the masses of two bodies as the inverse ratio of the accelerations produced by a given force, because this ratio is the same for all forces.

MEASUREMENT VERSUS UNDERSTANDING

FORTY or fifty years ago, after the system of electric and magnetic measurements had been fully established, every physicist had come near to a belief which was voiced by Sir William Thomson when he said that "when you can measure a thing you know all about it," and this point of view reached its climax in the days when physicists almost without exception believed that all subsequent development in their science would be to add significant figures farther and farther to the right of the decimal point! This point of view has, however, been swept away by the discoveries of recent years, and yet its germ seems to cling to some of the older phases of natural philosophy, for it comes to life in nearly every one's mind when any of the long-established principles of physics are contemplated. This is illustrated by nearly everything that has been said of recent years concerning the laws of motion. The measurement of force and the measurement of mass seem to be mixed up inextricably with the experimental aspects of the laws of motion in nearly every one's mind, whereas, as it seems to us, the laws of motion appear in their simplest and most clearly intelligible form when forces and masses (bodies) are not measured but merely identified. Sir William Thomson's statement certainly represents an obsolete point of view, which no doubt Lord Kelvin would have admitted. You can know a lot about a thing even if you can't measure it, and if you can and *do* measure it under widely varying conditions you can find out a great deal more about it. But to be able to measure a thing is, in the last analysis, merely to have enough wit to read a clock, or a yard stick, or to use a balance.

Measurement versus understanding! It certainly does seem fair so to characterize the difference between the natural philosophy of forty years ago and the natural philosophy of to-day; and no one shows a keener insight into the changing point of view than Karl Pearson[1] when he insists that after all physics, like botany, is a descriptive science.

INERTIA AND MASS. THE ESSENCE OF MATHEMATICAL PHYSICS

THE inverse ratio of the accelerations produced in two bodies by a given force is spoken of above as the ratio of the masses of the two bodies. Let us speak of this as the *ratio of inertias*, and let us reserve the word *mass* to designate the result obtained by weighing a body on a balance. Then the quantitative identity of mass and inertia is a discovery, but it is by no means a discovery which should make us ashamed of the balance as an instrument of precision.

Let us retain as the fundamental meaning of the word mass *the result of weighing on a balance scale*. Indeed, the laboratory man would laugh at any one who pretended to do otherwise; beware of the laugh of the laboratory man, *he* can satisfy the man from Missouri!

Yes, but the ratio of inertias is a more absolute thing than the ratio of masses because the balance must be on earth! But is it? No one can imagine a celestial operation which would show the ratio of inertias of two lone bodies without a third body of some kind acting.

[1] See Pearson's "Grammar of Science."

Then why object to the earth as a third body? We, for our part, thank the Lord for the Earth! We are satisfied with it!

Yes, but the balance compares the forces with which the earth pulls on two bodies—the weights of the two bodies. Very true, but just here is involved the one thing above all others which makes physics a mathematical science, and it is a thing which many of our mathematicians seem to think least about, namely, the establishment of invariant one-to-one correspondences by experimental tests. Use a balance on a batch of sugar and you get always and everywhere the same numerical result,[1] use it on a part of the batch and you get a different result. This is the only condition that is necessary to justify the use of the result as a measure of quantity of sugar. The purely arithmetical condition that ten units of sugar break up into a batch of seven units, and a batch of three units might also seem to be a necessary condition, but it is not necessary, but only convenient, in that it leads to a simple system of sugar-arithmetic.[2]

We respect the experience of two thousand years in that we base our definition of mass on the use of the balance; and we look at the identity of inertia ratio and mass ratio as a discovery, but we refuse to depart from the point of view of men who buy flour and sugar by the pound. We are not ashamed of the balance!

We also respect the broader view of mathematics as the logic of fixed relations in our acceptance of experimentally established one-to-one correspondences as the essential basis of mathematical physics rather than the mere readings of numbers on sets of weights, and yard sticks and clock faces!

W. S. FRANKLIN,
BARRY MACNUTT

[1] This statement is somewhat idealized for the sake of simplicity. If the use of the balance did always lead to invariant results, the rational theory of the balance would be of interest to the balance maker and to the speculative philosopher, but it would be of no consequence whatever to the experimental or mathematical physicist. As things stand, however, the rational theory of the balance is of importance in the elimination of what we call systematic errors, for under ordinary conditions the balance does not lead to invariant results. Many such cases arise in physics, and it is the common practise to keep clear of such complications in the earlier stages of the development of physical theory by framing definitions on the basis of ideal conditions.

[2] As an example of the kind of thing here referred to let us agree to measure "amperes" by the number of units of heat generated in a given wire per second. Then 3 "amperes" from one branch of a circuit joining with 2 "amperes" from another branch would give 11.9 "amperes" in the main circuit. In this system the arithmetical form of Kirchhoff's law would be as follows: The current in the main circuit is equal to the square of the sum of the square roots of the currents in the various branches of the circuit. Similarly sugar could be easily measured so that you would pay 5 cents for one unit, 7 cents for two units, 8.65 cents for three units, and so forth, without making the serious mistake of giving your sugar at a cheaper rate to the wealthy man who gets more than he needs than to the poor man who needs more than he gets. Figure it out for yourself.

POWDERY SCAB OF POTATOES IN OREGON

THE occurrence of the *Spongospora* scab disease of potatoes in Tillamook County, Oregon, has recently come to the attention of the department of plant pathology of the Oregon Experiment Station, and since this important trouble has apparently not been reported west of the Rocky Mountains the record may be of general interest.[1]

The lot of potatoes in which the disease was first found was raised on a farm in the rather isolated coast district of Oregon referred to above. The owner stated that the seed of this variety had been introduced from twelve to fifteen years ago from an eastern state and that new seed had not been introduced on his farm since that time.

The diseased tubers first found came from a lot that had been shipped to the writer for experimental study, this particular lot being badly affected with an internal browning apparently of non-parasitic origin and with the

[1] Since the above was written a record of the appearance of this disease in Seattle on potatoes from British Columbia has been reported.

Verticillium wilt. The variety was characteristically rough and the powdery scab pustules were not easily detected; in fact only one specimen was noticed at the time the tubers were being cut when examination was made for the other trouble. This specimen was laid aside and examination was not made for several days, when the identity of the disease was established, April 26, 1915. On reexamination several other specimens were found in this lot.

A rather hasty survey of Tillamook County was made at once (May 3–8, 1915) and, except on the farm from which the specimens above noted had been sent, only one specimen was found. This specimen was picked up in a grocery store in Tillamook with no possible chance of tracing it to the grower. At the farm from which the first lot was received about two dozen specimens were found on examining about three bushels of potatoes.

The fact that the district is isolated and that potatoes are not raised in sufficient quantity for export possibly has been a natural means of preventing a more general dissemination of the disease. F. D. BAILEY

AGRICULTURAL EXPERIMENT STATION,
CORVALLIS, OREGON,
July 10, 1915

SCIENTIFIC BOOKS

Spencer Fullerton Baird. A Biography. Including selections from his correspondence with Audubon, Agassiz, Dana and others. By WILLIAM HEALEY DALL, A.M., D.Sc. J. B. Lippincott Company. 1915. 8vo, 462 pages, 19 plates.

Dr. Dall has conferred a distinct and lasting benefit on American science and letters by his presentation of the life of one of America's most eminent and beloved men of science. In the twenty-eight years that have elapsed since death terminated the career of Spencer Fullerton Baird, his fame has not diminished, the respect in which he was held as a man and scientist has not abated, and his example has been an inspiration to thousands. For no previous biography has anything approaching completeness been claimed; and it is safe to say that posterity will demand nothing more than is herein contained, for no subsequent biographer will have access to any essential facts or data that were not available to and utilized by Dr. Dall. Chief among the sources of information were Professor Baird's journal, extending, with certain breaks, from 1838 to 1887; letters selected by his daughter, which for the period prior to 1865 are mostly from his correspondents, as the official archives and Baird's own official letters were destroyed in the burning of the Smithsonian building in that year; reminiscences written from Miss Baird's dictation; and a mass of miscellaneous documents and notes that had been collected by Mr. Herbert A. Gill, who for many years had been associated with Professor Baird in the work of the Fish Commission.

The volume is with great propriety dedicated "To the memory of a devoted daughter, Lucy Hunter Baird," the only child of Professor Baird. It was she who began the collection of material on which she intended to base a memoir of her father; and it was she who, finding that she would be unable to complete that task, devised her own and her father's papers to the executor of her will with the request that the "memoir be completed by a suitable and competent person."

The task and the honor of writing a biography of Professor Baird could have been entrusted to no person more competent and sympathetic than Dr. Dall, who, as stated in his preface, had known Professor Baird since 1862, had had the benefit of his teaching and example from 1865 to the time of his death, had enjoyed the hospitality of the Baird home, and from 1869 had knowledge, at the time of its occurrence, of much that is recorded in the biography.

The biographer makes no attempt to enumerate or analyze Professor Baird's voluminous publications, which have already been covered by Professor G. Brown Goode's exhaustive bibliography. The author's "chief aim has been to show the man as he lived and worked; with glimpses of his relations to his contemporaries, to the promotion of science, and to great, and as yet hardly appreciated, public services."

The genealogical and family notes with which the memoir opens are followed by chapters on Childhood and Youth; Life at Carlisle; The Young Professor; The Smithsonian Institution; Life in Washington; 1850 to 1865; 1865 to 1878; The Secretary, 1878 to 1887; The U. S. National Museum; The U. S. Commission of Fish and Fisheries; and Appreciations.

The following epitome covers the principal events in the life of Spencer Fullerton Baird: He was born in Reading, Pa., February 3, 1823. His father died in 1833, and his mother then moved to Carlisle, Pa., where in 1835 he attended the grammar school, an adjunct of Dickinson College. In 1836, at the age of thirteen, he entered that college, of which his father had been a member of the academic senate and his two brothers were already students. After receiving the degree of A.B. in 1840, he began the study of medicine, and in 1841 and 1842 attended lectures at Bellevue Hospital, New York. This subject proving distasteful, he returned to Carlisle in 1842, and resumed his academic studies, taking the degree of A.M. in 1843. In 1845 he was made honorary professor of natural history at Dickinson, and in the following year became full professor, a position held until 1850. His salary, which at the outset was $400 a year, was increased to $650 at the end of the first term and to $1,000 in 1848. The first named salary being regarded as sufficient "to make a start," he married Miss Mary Helen Churchill, of Carlisle, on the strength of his professional appointment. In 1850, following letters written in his behalf by Audubon, Marsh, Dana and Agassiz, and on the nomination of Professor Joseph Henry, Baird, at the age of twenty-seven years, was elected assistant secretary of the Smithsonian Institution. This position was held until the death of Professor Henry in 1878, when Baird was immediately and unanimously chosen as his successor by the board of regents. Meanwhile in 1871, the position of commissioner of fish and fisheries had been created and Baird was appointed thereto by the President. On Baird's presentation of the need for and value of a suitable deapository for the government collections, Congress in 1879 appropriated money for a fireproof building for that purpose, and Baird became the ex-officio director of the National Museum. The three positions—secretary, commissioner and director—were held until his death in 1887.

At a very early age Baird evinced a predilection for natural history that was to shape his career and make him one of the greatest systematic and economic biologists that has ever lived. The part of the work which gives the best insight into his early aims, ambitions, traits and habits of thought, as well as into his later plans, methods and aspirations, is the verbatim correspondence between Baird, the members of his family, and scientific and public men. These letters number about 225, and extend from 1831 to 1887. Especially interesting is the intimate correspondence between Baird and Audubon which began in 1840, when the young naturalist ventured to write the most distinguished ornithologist of the United States regarding two flycatchers he could not identify, and continued actively for more than seven years.

This and other correspondence show that Baird's capacity for making and retaining worth-while friendships was due to his zeal, candor and accurate knowledge of his subject, combined with great modesty and a dignified manner. Among the prominent scientific men with whom he became acquainted while still in his teens were, in addition to Audubon, George N. Lawrence, James De Kay, J. P. Giraud, John Torrey, Thomas Nuttall, Samuel G. Morton, T. A. Conrad, James D. Dana, John Cassin, Titian R. Peale and Isaac Lea. This acquaintance and association undoubtedly influenced and strengthened the trend of Baird's studies, which, before his twenty-fifth year, were confirmed and broadened by intercourse with John and Joseph Le Conte, Joseph Leidy, Thomas M. Brewer, Amos Binney, Oliver Wendell Holmes, Asa Gray, A. A. Gould, D. H. Storer, the Sillimans, James Hall, Sir Charles Lyell, George P. Marsh, J. P. Kirtland, Joseph Henry and Louis Agassiz. Especially noteworthy are the series

of letters reproduced in the memoir passing between Baird and Louis Agassiz, James D. Dana, George P. Marsh and Joseph Henry.

The early interest which Baird manifested in fishes increased with age and ultimately was responsible for the genesis and organization of the federal fishery service with which his name is ineffaceably associated. In 1848 specimens of the fishes from his collection were sent to Louis Agassiz, and arrangements had been made for a joint work on American fishes; this, however, owing to Agassiz's more pressing projects, never materialized and, after a few years, was abandoned by mutual consent. In 1854 we find Baird spending a summer vacation on the New Jersey coast and making there a collection of fishes which served as a basis for a noteworthy report. As early as 1863 Baird visited Woods Hole, Mass., and was impressed with the richness of the local marine fauna, and during the next few years he became greatly interested in the fisheries of the Atlantic coast and realized the need for a comprehensive investigation of the causes underlying the reported decrease of certain fishes. A comparison between conditions found in southern New England waters in 1863 and during a visit in 1870 strengthened his desire for authoritative investigation which would supplement the inquiries that had been undertaken by the various states. The psychological time having arrived; Baird having submitted a plan to Congress; the American Fish Culture Association having espoused the idea of federal aid to the fisheries; and state and national legislators, the general public and the fishery interests being in accord, Congress in February, 1871, passed a joint resolution drawn up by Professor Baird and Senator George F. Edmunds which made provision for a commissioner of fish and fisheries and for investigations to be conducted under his direction. President Grant did the obvious thing in appointing Baird to the newly created office, and there were thus imposed on an already busy man additional duties and responsibilities which yearly became more onerous and pressing and ultimately claimed a large proportion of his attention and time.

In 1871 Woods Hole became the headquarters of the commission, and then and there were laid the foundations of the first permanent marine laboratory in America. While the investigations were still in their incipiency, Baird formed the plan of inviting zoological students to visit Woods Hole to avail themselves of the large amount of material daily brought in that did not bear directly on the work of the commission, and he arranged for table and other facilities and cheap board. Thereafter Baird regularly spent his summers on the New England coast directing the local investigations while administering the business affairs of an organization that yearly acquired new functions and extended its activities into new regions. Woods Hole was the scene of his principal activities as it was the spot of his warmest regard. It was there that, advised and aided by men like George Brown Goode, Jerome H. Kidder, Theodore Gill, Richard Rathbun, Z. L. Tanner, H. C. Chester, A. E. Verrill, Alpheus Hyatt, W. G. Farlow, John A. Ryder and Sydney Smith, he planned and inaugurated those noteworthy biological, fishery and fish-cultural operations which soon brought the United States into the forefront of the nations in all such matters.

Long-continued overwork, more particularly that imposed by his unsalaried services as fish commissioner, began to tell on Professor Baird's strength, and in 1885 his cares were aggravated by unscrupulous newspaper attacks on the activities and personnel of various scientific bureaus of the government, including the fish commission. In July, 1886, after consultation with Dr. Weir Mitchell and Dr. William Osler, he went to Woods Hole, and remained there until late October. Fully aware of his physical condition, he presented his case to the board of regents at the 1887 meeting, and made arrangements for the election of his successor as secretary of the Smithsonian Institution. In July, 1887, he again went to Woods Hole; and there, "the scene of his hardest labors and most striking economic successes," the place that typified that governmental bureau in which he took such pride and which

was peculiarly his own in conception and organization, he died on August 19, 1887.

In selecting material for the chapter on Appreciations from the large assortment of available data, Dr. Dall has exercised admirable discrimination. It may not be inappropriate to quote therefrom an extract from a biographical memoir presented to the National Academy of Sciences by Dr. John S. Billings in 1889:

"The two men who have exerted the strongest influence upon natural history studies in this country are Louis Agassiz and Professor Baird. In many respects they were very unlike; circumstances gave them widely different fields, and they worked on different plans and by different methods. They began their public career in this country almost together; but Agassiz was already famous, as the result of seventeen years' work, while Baird was an almost unknown youth. Agassiz was a born teacher, a fascinating lecturer, gifted with eloquence which won its way everywhere; Baird could only speak freely in the presence of a few, and for the most part taught only by the pen and by example. Each of them created a great museum in spite of many obstacles, the first winning the means largely from private contributions, which were a tribute to his eloquence; the second gaining his end more indirectly, through his connection with the Smithsonian Institution and the government. Each of them gathered around him young men who were stimulated and encouraged by his example, who followed his methods, have continued his work, and have taught others, so that there are now observers and workers almost everywhere. The first made great use of the microscope and of embryology; the second very little, for he had to use the material available. The first had a vivid imagination which led him to frame many theories and hypotheses to be verified or disproved by future investigation and research; the second classified the facts before him, but theorized very little. Professor Baird's career as an original investigator was hampered and finally stopped by his administrative work, but in proportion as this latter increased he was able to furnish materials and opportunities for others. The pupils of Agassiz and Baird are the working naturalists of to-day and the teachers of those who are to come, and the two methods of study are being combined and developed to produce results of which we already have good reason to be proud, and the end of which no man can see.

"Upon the roll of the illustrious dead of the National Academy of Sciences his name stands out as that of a scientific man of high attainments, uniform purpose and indomitable energy, whose work has already added to the comfort and pleasure of hundreds of thousands of his fellow men, and bids fair to be a most important factor in supplying the necessities of millions yet unborn."

The merit, the charm, the permanent literary and historical value of this noteworthy volume can not be told in a review such as this. The work is no mere formal biography. It is a sympathetic analysis of the aspirations and labors of one friend by another; it is an appreciation of the work of one scientist by another; it is a simple, dignified, forceful narrative by one whose personal knowledge of the man and his times gave him a right to supplement the statement of facts with authoritative comment and criticism.

To those who knew Professor Baird, the volume of Dr. Dall comes as a delightful memento. To those contemporaries who had no personal acquaintance with him, it serves as a faithful record of one whose name and work are well known to all. To the generation that has come into being and reached maturity since Professor Baird's death, it is a fascinating history and an inspiring revelation.

Hugh M. Smith

Woods Hole, Mass.,
August, 1915

Chemical Technology and Analysis of Oils, Fats and Waxes. By Dr. J. Lewkowitsch. Edited by George H. Warburton. Fifth edition, entirely rewritten and enlarged. Volume III. New York and London, Macmillan and Co., Ltd. 1915. Pp. 488. Price, $6.50.

This volume deals with the technology and industries of the products named, and their analysis, also with the testing of lubricating oils and greases, soaps, glycerine and candles. A very important chapter is that on the waste oils, fats and waxes, and the products derived therefrom.

The reviewer knows of no treatise which deals so thoroughly with this phase of the subject. The contents have been increased by about twenty per cent., the principal additions being made in the sections upon the examination of butter, hydrogenated fats, varnishes, candles and soap. The work is encyclopedic, no omissions being noted, and indispensable to those having to deal with these compounds, or industries, which are among the most important. The reviewer would again take the opportunity to urge the inclusion of an index in each volume, as much increasing its consulting value.

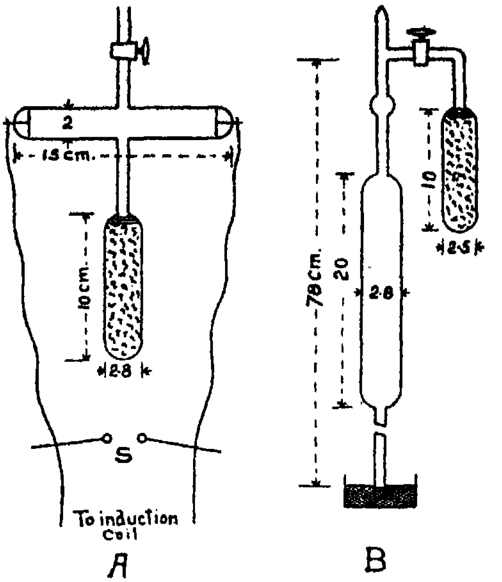
A. H. Gill

SPECIAL ARTICLES

THE ABSORPTION OF AIR BY CHARCOAL COOLED TO THE TEMPERATURE OF LIQUID AIR

The remarkable absorption of certain gases by charcoal cooled to the temperature of liquid air, first pointed out by Ramsay and Soddy, may be exhibited conveniently by either of two simple pieces of apparatus. The first (*A* in the figure) makes use of the electric discharge as an index of the degree of absorption; while the second (*B* in the figure) indicates the absorption by the barometric column supported in a vertical tube dipping into a bath of mercury.

The general form and dimensions of the discharge-tube and its attached charcoal bulb are indicated in *A*. The volume of the charcoal used should be approximately equal to that of the discharge tube proper. A vent closed by a valve is included. For the experiment to be in its best form the cocoanut charcoal should be freshly burned, and to prevent undue absorption of air when not in use the tube should be partially pumped out and the valve closed. The connections are made as



shown in the figure, in which *S* is an alternative spark gap of about one centimeter length in parallel with the discharge tube. Any induction coil about the laboratory will answer. To operate, open the valve, then close it tightly, thus allowing the pressure within the tube to become atmospheric. On starting the induction coil the spark will pass at *S*. Now gently submerge the charcoal bulb in liquid air. In about one minute the spark at *S* will begin to weaken and a stringy discharge will appear between the electrodes of the discharge tube. Soon the spark at *S* will cease while the tube will be filled with the characteristic Geissler tube glow. In about four minutes the walls of the discharge tube will begin to flouresce, due to the bombardment of cathode rays. The intensity of this fluorescence will rapidly increase and soon the entire tube will be uniformly filled with a beautiful apple-green color. In about one minute more, five minutes from the start, the greenish color will begin to fade and sparking will *reappear* at *S*, showing that the vacuum in the tube is becoming "hard." In short the pressure may thus be reduced from atmospheric to about .001 mm. mercury in five or six minutes with no other agency than that of the absorption

of air by charcoal cooled to the temperature of liquid air.

The second method of showing the absorption of air, due to Dr. L. T. Jones, is at once clear by an inspection of *B* in the figure. The vertical stem, up to the branch leading to the charcoal bulb, should be at least 78 cm. long. This stem may also have an enlargement about half way up as shown. A valve should be included to protect the charcoal when not in use. Before starting the experiment the valve is opened and the tube mounted in a bath of mercury. Liquid air is then applied to the charcoal bulb. The absorption proceeds slowly at first, but soon gains headway as the charcoal cools. The speed that the mercury column acquires as it rises up through and fills the enlargement is surprising. Even with the ratio of volume of tube to charcoal as shown in the figure (approximately 4:1) the mercury column will mount to nearly full atmospheric pressure in the short space of five or six minutes.

Added interest is to perform the two experiments simultaneously.

CHAS. T. KNIPP
LABORATORY OF PHYSICS,
UNIVERSITY OF ILLINOIS,
August, 1915

OCCURRENCE OF THE PROTOZOAN, COLACIUM MULTOCULATA KENT, IN IOWA

IN making collections of *Daphnia,* and other Entomostraca, on October 31, 1914, the writer discovered a small pond near Iowa City, Iowa, which fairly teemed with *Daphnia* of a striking green color.

Examination of these specimens in the laboratory revealed the cause of the coloration to be myriads of individuals of the Protozoa bearing chromatophores and being attached to the surface of the *Daphnia* completely covering, not only the body proper, but even the appendages in many cases.

These Protozoa yielded themselves readily to identification as belonging to the genus *Colacium*—Flagellates closely related to *Euglena* but differing therefrom in one essential, among others, of having a sedentary attached stage as well as a free-swimming stage. In the sedentary stage the individual zooids are attached by pedicles to some object or, as is more often the case, to some other form of animal life.

Kent (1881) mentions, at the close of his discussion of the *Colacium,* a supplementary species for which he proposes the provisional name of *Colacium multoculata.* It is with his description of this species that the animals under the observation of the writer most favorably compare.

As with Kent the writer demonstrated a very short pedicle and in no case was more than a single individual found on one pedicle. There is a general tendency for the animal to assume a quadrate-elliptical form in outline both when free-swimming and fixed, with an occasional broadening near the distal end. The shape is subject to more or less continual change. The chromatophores are very large and seem to be distributed near the periphery of the cell. Kent describes the presence of from two to four red spots instead of the single one commonly present and from this character proposes the name of the species. By far the most of the specimens examined by the writer possessed but one spot, some half dozen individuals from the many showed from two to four as described. In as much as the differing specimens agreed in all other essential characters they were undoubtedly variations of the same species. The possession of a flagellum by the free-swimming form was amply demonstrated.

Edmondson in his treatise on the Protozoa of Iowa[1] includes *Colacium* in his key to genera but states that no species of this genus has been reported within the state. It is probable that other species closely related to the one forming the subject of this note may be added to the list of Iowa Protozoa.

D. M. BRUMFIEL
LABORATORIES OF ANIMAL BIOLOGY,
STATE UNIVERSITY OF IOWA

SPORE MEASUREMENTS

THE usual way of giving measurements of spores as width by length in μ is clear and

[1] Davenport Academy of Sciences, 1906.

satisfactory when the dimensions do not vary too much and are fairly constant. Identification by a given description becomes difficult when either one or both dimensions vary between wide limits. The distinguishing dimensional features of the æciospores of a given species, for instance, are not determined by the lowest and highest values (*e. g.*, 15–26 by 22–41μ) that the spores may attain, but by the most common combinations of width and length measured; that is, by the standard values. The latter can not be expressed in averages, which will vary with the numerical basis used and with the personal factor in picking out the spores to be measured. The numerical basis in particular is a factor which has been almost totally neglected in descriptions. I propose to give, in all cases but those of very constant measurements, a formula containing the numerical basis, the extreme range of width and length and the most common combinations of width and length found. The formula in our example would read: (48) 15–26μ by 22–41μ (19–22 by 26–30μ). (48) is self-explanatory; it gives the numerical basis; that is, the number of spores measured. 15–26μ by 22–41μ are the extreme measurements of width and length. (19–22 by 26–30μ) are the standard values of width and length. These values are found by arranging all measurements in two progressive tables, one by widths, the other by lengths. It is then an easy matter to find the most common values.

In cases where misunderstandings may arise the formula can be given as follows: (48 measured) 15–26μ by 22–41μ (standard 19–22 by 26–30μ).

For all measurements of a simple nature the old formula can still be retained, although the numerical basis should in every case be given. The method is, of course, not confined in its usefulness and accuracy to spores alone.

E. P. MEINECKE

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE North Carolina Academy of Science held its fourteenth annual meeting at Wake Forest College on Friday and Saturday, April 30 and May 1, 1915. The reading of papers began at 2:50 P.M. on Friday and continued until 5:30, at which time adjournment was had, followed by the annual meeting of the executive committee. At night Dean Charles E. Brewer, of Wake Forest College, made the academy welcome to the college. President J. J. Wolfe, of the academy, then delivered his presidential address, "The Status of the Theory of Descent." Next Professor John F. Lanneau delivered a lecture "The Cosmoid," illustrated by an apparatus of his own design; and Professor A. H. Patterson gave a short talk on "The Importance of Humidity in Health and the Arts" with a demonstration of an interesting form of humidifier of North Carolina manufacture.

The academy met in annual business meeting on Saturday morning. Reports of the secretary-treasurer and of the various committees were made and an invitation for the academy to hold its next annual meeting at the State Agricultural and Mechanical College was accepted. An interesting discussion on the matter of membership was held and it was resolved to try to bring into the academy in 1916 all the scientific people of the state. To this end a large and representative canvassing committee was appointed. Ten new members were elected, who bring up the total membership to date to 70.

The following officers were elected for 1915–16.

President—A. S. Wheeler, University of North Carolina, Chapel Hill.

Vice-president—W. A. Withers, State Agricultural and Mechanical College, West Raleigh.

Secretary-treasurer—E. W. Gudger, State Normal College, Greensboro.

Additional members executive committee—Z. P. Metcalf, State Agricultural and Mechanical College, West Raleigh; W. C. Coker, University of North Carolina, Chapel Hill; E. T. Miller, Trinity College, Durham.

At the close of the business meeting, the reading of papers was resumed and continued until 1:30 when the program was finished. The total attendance was 31 out of a membership of 70. There were 23 papers on the program, of which only three were read by title. Perhaps the most marked feature of the meeting was the considerable discussion which followed the reading of many of the papers. Including the presidential address, which will be published in the current number of the *Journal* of the Elisha Mitchell Scientific Society, the following papers were presented:

An Outline of Modern Work bearing on the Theory of Descent: J. J. Wolfe.

Previous to 1900 the evolutionary hypothesis stood practically as Darwin left it in 1859. During the intervening years a tremendous mass of facts accumulated which tend to support it, but on the other hand some weighty objections have also been offered. These were, however, apparently met by the mutation theory which appeared in 1901, but unfortunately it has latterly encountered even graver difficulties than Darwinism itself. Its critics, Jeffrey in particular, have brought forward very strong evidence tending to identify the phenomena of mutation with hybridization. If this criticism shall stand, mutation is robbed of any just claim to being an explanation of evolution.

On the other hand, the work of Johanssen and others appears to demonstrate that individual variations are not heritable and all that selection can achieve is to resolve a species into its component elements, the so-called "pure lines," and choose that pure line manifesting the character in question developed to its highest degree. It can not carry the development of this character one whit beyond the limit attained by the species as a whole.

Now, if mutation is but the reappearance of some recessive character, segregating out from a long and complex process of hybridization in accordance with Mendelian principles, as De Vries's critics seem to have rendered highly probable; and if variation in the Darwinian sense be non-heritable, as the pure line investigations appear to show, how has the transition from one species to another occurred? That this has repeatedly taken place would seem to be beyond intelligent doubt. For answer, so far as the author can see, we are limited to two views. We must either assume the inheritance of acquired characters, or that all characters were present in the primordial germ cell.

As regards the inheritance of acquired characters, much work has accumulated both for and against its acceptance. On the zoological side in particular experimentation tends to support the view that acquired characters are non-heritable, while on the botanical side the tendency is perhaps in the other direction. The germ tissues in plants are not as early set apart from the soma as in animals, and are not nourished in an environment so constant and so well protected from environmental effects. Perhaps these facts have some bearing on the question. Nevertheless, any such broad generalization found true for plants would also be true for animals, even if its operation could not be so easily and clearly observed.

The alternative hypothesis proposed by Bateson, that all characters were present in the primal organisms, while not a very satisfying view, finds a parallel in the development of the adult from the egg. The biological world is pretty well agreed that every important character manifest in the adult is represented in some way in the germ cell. If then the mature individual has arisen by differentiation and specialization from a single cell, manifestly it is not unthinkable to suppose that higher animals were likewise represented in the primordial protozoa.

With the evidence before us, conflicting as it is, it is clearly impossible at the present time to say how evolution has occurred, yet, if personal opinions are not out of place on an occasion of this kind, it may be said that the inheritance of environmental effects seems destined to play a more important part in the final solution of organic descent than is accorded it at the present time.

Desmotropy: Alvin S. Wheeler.

The first case of keto-enol isomerism among the phenols of the naphthalene series was recently reported by Willstaetter and Wheeler. Juglone, a dyestuff in green walnut shells, yields on reduction 1, 4, 8-trihydroxynaphthalene, melting at 152°. After once being melted it melts thereafter at 96°. Since this type of compounds is very sensitive to alkalies, weakly basic reagents as semicarbazine and phenylsemicarbazine were employed to detect the carbonyl group. The lower melting product was found to be the ketonic form. Some work, not yet published, on 1, 4, 5, 6-tetrahydroxynaphthalene reveals another case of this nature. Here, however, it has been impossible to separate the two forms, the compound melting at 154° responding readily to both enolic and ketonic reactions. Numerous isomerization methods fail to reveal another form. The application of Knorr's ferric chloride and Kurt Meyer's bromine method to approximate the relative amounts of the isomers present is not practicable to the above cases. Ferric chloride oxidizes the compounds to quinones while bromine enters the ring of either form.

The H-H Waterwheel and Pump for Farm Waterworks: T. F. Hickerson.

The Hutchison-Hickerson waterwheel and pump, recently invented by R. B. Hutchinson of Wilkinsburg, Pa., and T. F. Hickerson, of Chapel Hill, N. C., is a discovery of a new application of the

old principle of the overshot wheel in the design of a small easy running combination wheel and pump and stand (made in the factory complete for installation) to utilize the flow and fall of small brooks as power for operating continuously a pump which pushes pure spring water to higher elevations. The remarkable simplicity, adaptability and reliability of this machine brings it in direct competition with hydraulic rams, all of whose defects seem to be met satisfactorily by the wheel and pump. One dozen of these wheels and pumps have been introduced in North Carolina during the past year. Among these is one which delivers every day through a vertical height of 45 feet 500 gallons of spring water for a large farm home, where the power of the stream which operates the wheel is only $\frac{1}{100}$ of a horse power.

On Leidy's Ouramœba and its Occurrence at Greensboro, N. C.: E. W. GUDGER.

In the fall of 1914 considerable numbers of large and active ouramœbas were found at Greensboro. The amœbas themselves and the locality in which they were found were described. Their activities both in feeding and moving were discussed, and it was noted that there was no reversal of polarity, the tail-feather-like mass of fungous hyphæ always remaining posterior. The history of this interesting organism was then reviewed, and the conclusion arrived at that ouramœba (tailed amœba) is nothing but an ordinary amœba which has ingested fungous spores which have germinated and formed a mass of mould hyphæ which project from the posterior end of the animal. The full paper will be published shortly.

Some Igneous Rocks of Mount Collier: JOHN E. SMITH.

Mount Collier is in Orange County, N. C., about five miles west of Chapel Hill. It is typical of those igneous monadnocks of the eastern Piedmont, most of which rise to a common level about 200 feet above the peneplain. It was formerly much higher and of greater extent: this is shown by the position of parts of the mountain that have been separated from it by erosion, also by the fact that Ball Mountain, in Davidson and Rowan counties, of similar rock and structure, has been cut by a river (Yadkin) which flows through it. That the upland level of the region is a peneplain is also proved by the presence of smooth, rounded quartz pebbles on this plain. The mountain consists chiefly of dark rhyolite which made its way upward along the contact between the ancient crystalline schists north of it and the granite on the south. On each of its slopes flow structure has been observed in the weathered rock and in many places where it is fresh. It is called Mount Collier in honor of Professor Collier Cobb, who, in 1892, was the first to recognize its igneous origin. (Specimens and structure sections were used in presenting the paper.)

Some Observations on the Red Cedar: H. R. TOTTEN.

Juniperus virginiana is probably the only one of the four eastern species of *Juniperus* growing in North Carolina. *Juniperus communis* has been credited to the state, but its presence is doubted. The male and female flowers of *Juniperus virginiana* are borne on separate trees. The time of flowering is dependent upon the climate and weather. The male trees begin blooming first and the return of cold weather may delay the female trees. In both the seasons 1914 and 1915 the male trees began blooming nearly six weeks before the female trees. The young "berry" is formed soon after pollination by the growth and fusion of the sporophylls about the ovule. Fertilization takes place about the middle of June. The seeds are matured in the first season. The species is very variable in color and habit of growth, varying in the neighborhood of Chapel Hill and Durham in color from a glaucous to a deep green, and in form from an open spreading tree to a close spreading tree and to a narrow columnar tree.

Seasonal Distribution of the Army Worm Moth at Raleigh, N. C.: C. S. BRIMLEY.

Gives the result of some observations on the abundance of the army worm moth (*Leucania unipuncta*) at Raleigh in 1914, determined by the number caught on a number of nights in a "sugar"-baited moth trap. The observations began in mid-August, 1914, and have continued to the present time, May 7, 1915. The full data will appear in the current number of the *Journal* of the Elisha Mitchell Scientific Society.

Significance of Gossypol in the Cotton Plant: F. E. CARRUTH.

Gossypol, $C_{15}H_{14}O_4$ (or possibly $C_{32}H_{34}O_{10}$) according to Marchlewski[1] appears to be a dihydric (ortho) phenol. It occurs in peculiar glands, "resin glands," in all parts of the cotton plant. Its physiological significance is not clear. The change in color of the cotton flower on aging is probably due to it. It is a yellow substance, dissolving in H_2SO_4 with a red color and oxidizing easily in alkaline solution with a deep blue color.

[1] *J. Prakt. Chem.*, 1899, 60, p. 80.

It is being studied in an endeavor to show that it is a respiration pigment or an anthocyanic substance, rather than an end-product of plant metabolism. An effort to elucidate its constitution is being made by the North Carolina Experiment Station.

Fly-parasites as a Factor in controlling Army-worm in North Carolina in 1914: F. SHERMAN.

The army-worm (*Heliophila unipuncta*) was destructive in many localities in North Carolina in 1914, attacking millet, grasses and grains. Tachina-flies were abundant and laid eggs on the worms. A lot of 534 army-worms was separated into groups according to number of eggs per worm, and rearings made. Worms without visible eggs matured less than 10 per cent. of moths. Of worms with fly-eggs less than 1 per cent. matured moths. Highest development of flies was from worms with 3 parasitic eggs each (32.81 per cent.), the rate consistently declining both below and above that point. On all worms collected, the average was 2.44 fly-eggs per worm, close to the desired optimum. Outbreaks were of short duration and there was no widespread damage by any later broods. A more detailed article covering this work will be found in *Journal of Economic Entomology* for April, 1915.

On the Myth of the Ship-holder, the Echeneis or Remora: E. W. GUDGER.

A brief account was given of some of the data relating to this myth, which began about the time of Pliny the Elder and persisted until about 1660. The true explanation was given by Ekman in 1904 in his work on "dead water." Material and data are being collected for a series of papers giving accounts of and explaining the myth, describing the use of the remora as a living fish hook, and lastly, giving as fully as possible the natural history of the fish—the matter of chief interest being the origin of the sucking disk.

The Sexuality of the Filament of Spirogyra: BERT CUNNINGHAM.

The general opinion, as shown by Wood (1872), Wolle (1887), DeToni, Klebs (1896), Vines, Bennett and Murry, and Mottier (1904), is that the filaments contain cells of one sex. West (1904), basing his assertion upon Hassall (1845), states that cross conjugation is exceedingly rare in Conjugales. The writer found a *Spirogyra* which follows the general description of Quadrata, with the exception of reproduction. This frequently occurred as cross conjugation, the zygotes being in such a position that it could not possibly be a combination of lateral and scalariform conjugation. This occurrence would tend to prove that the filaments of some *Spirogyra* at least are truly bisexual, and that the transition from the bisexual to the unisexual occurred in the family of *Spirogyra*.

Abnormal Specimens of Taraxacum: S. W. GEISER.

This paper notes the occurrence of a clump of dandelions at a point 70 feet E.N.E. of the N.E. corner of Cox Hall, on the campus of Guilford College. Seven specimens showed well fasciation of the flower-stipes. The multiple-headed character was not so pronounced as noted by Kirsch ('09): only two or three stipes in each of the specimens were united. The flower heads were either slightly confluent or independent. At the point of collection, the soil was unusually infertile, and the occurrence suggests Nieuwland's ('09) conclusion that the abnormality is due to a physiological change due to unfavorable soil conditions, and to age. Bowditch ('09) has also noted fasciation of the dandelion (*T. off.*) in an unfavorable environment. Diligent search failed to find abnormal specimens outside of the local circumscribed area.

For the following papers no abstracts have been received.

"The Present Status of the Martian Controversy," by A. H. Patterson.

"Filose Phenomena in Pieces of Gonads of a *Cubomedusa*," by H. V. Wilson.

"More Fossil Plants from the Moncure Shales (32 specimens)," by Collier Cobb.

"Cow Pea Weevil," by Z. P. Metcalf.

"Gossypol, the Toxic Substance of Cottonseed Meal," by W. A. Withers and F. E. Carruth.

"The Influence of Salt Solution on the Development of the Frog Egg," by W. C. George.

"Experimental Alteration in the Direction of Growth of a Sponge," by H. V. Wilson.

"The Importance of Humidity in Health and the Arts (with demonstration of a new form of Humidifier of North Carolina Make)," by A. H. Patterson.

"Simplifying our Methods of Teaching Cell Division," by Z. P. Metcalf.

"Monadnocks and Metamorphism in the Cretaceous Peneplain," by Collier Cobb.

"The Origin of the do, re, mi Syllables for the Musical Scale," by A. H. Patterson.

"Notes on Geology of Smith's Island," by Collier Cobb.

E. W. GUDGER,
Secretary

SCIENCE

FRIDAY, OCTOBER 1, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CONSTRUCTION OF THE HEAVENS[1]

ALTHOUGH at the present time our minds are largely absorbed by the war, the meeting of the British Association in Manchester indicates that we consider it right to make our annual review of scientific progress. I shall therefore make no apology for choosing the same subject for my address as I should have chosen in other circumstances. It is a subject far removed from war, being an account of the manner in which astronomers have with telescopes and spectroscopes investigated the skies and the conclusions they have reached on what Herschel called "The Construction of the Heavens."

Our knowledge of the fixed stars, as they were called by the old astronomers, is of comparatively recent origin, and is derived from two sources: (1) the measurement of small changes in the positions of the stars in the sky, and (2) the analysis of the light received from them and the measurement of its amount. To this end the numerous instruments of a modern observatory have been devised. The desire to examine fainter objects, and still more the necessity of increasing the accuracy of observations, has brought about a continuous improvement in the range and accuracy of astronomical instruments. Methods which had been perfected for observations of a few stars have been extended so that they can be applied to a large number. For these reasons the progress of sidereal astronomy may seem to have gone on slowly for a time. The more rapid progress of recent years arises

[1] Address of the President of the Section of Mathematics and Astronomy at the Manchester meeting of the British Association for the Advancement of Science.

from the accumulation of data, for which we are indebted to generations of astronomers, and from the gradual increase in power and perfection of our instruments.

The first insight into the stars as a whole naturally came from the survey of their numbers and distribution; and Herschel, who constructed the first great telescopes, explored the heavens with untiring skill and energy, and speculated boldly on his observations, is justly regarded as the founder of sidereal astronomy. In his great paper "On the Construction of the Heavens," Herschel gives the rules by which he was guided, which I should like to quote, as they may well serve as a motto to all who are engaged in the observational sciences:

> But first let me mention that if we would hope to make any progress in an investigation of this delicate nature we ought to avoid two opposite extremes of which I can hardly say which is the most dangerous. If we indulge a fanciful imagination and build worlds of our own, we must not wonder at our going wide from the path of truth and nature; but these will vanish like the Cartesian vortices, that soon gave way when better theories were offered. On the other hand, if we add observation to observation, without attempting to draw not only certain conclusions but also conjectural views from them, we offend against the very end for which only observations ought to be made. I will endeavor to keep a proper medium; but if I should deviate from that I could wish not to fall into the latter error.

In this spirit he discussed the "star gauges" or counts of stars visible with his great reflector in different parts of the sky, and concluded from them that the stars form a cluster which stretches to an unknown but finite distance, considerably greater in the plane of the Milky Way than in the perpendicular direction. He gave this distance as 497 times that of Sirius. He did not hesitate to advance the theory that some of the nebulæ were similar clusters of stars, of which that in Andromeda, judging from its size, was the nearest. Herschel had no means of telling the scale of the sidereal system, though he probably supposed the parallax of Sirius to be of the order of 1″.

Though some of the assumptions made by Herschel are open to criticism, the result at which he arrived is correct in its general outline. I shall attempt to give a brief account of some of the principal methods used to obtain more definite knowledge of the extent and constitution of this "island universe." The stars of which most is known are, in general, those nearest to us. If the distance of a star has been measured, its coordinates, velocity perpendicular to the line of sight, and luminosity are easily found. In the case of a double star the orbit of which is known the mass may also be determined. But only a very small proportion of the stars are sufficiently near for the distance to be determinable with any accuracy. Taking the distance corresponding to a parallax of 1″ or the parsec as unit—*i. e.*, 200,000 times the distance of the earth from the sun—fairly accurate determinations can be made up to a distance of 25 parsecs, but only rough ones for greater distances.

For much greater distances average results are obtainable from proper motions, and the mean distances of particular classes of stars—for instance, stars of a given magnitude or given type of spectrum—can be found with confidence up to a distance of 500 parsecs, and with considerable uncertainty to twice this distance. The density of stars in space as a function of the distance, the percentage of stars within different limits of luminosity, the general trend of the movements of stars and their average velocities can also be found, within the same limits of distance.

For all distances, provided the star is sufficiently bright, its velocity to or from the earth can be measured. The general

consideration of these velocities supplies complementary data which can not be obtained from proper motions, and confirms other results obtained by their means. For distances greater than 1,000 parsecs our knowledge is generally very vague. We have to rely on what can be learned from the amount and color of the light of the stars, and from their numbers in different parts of the sky.

PARALLAX

Let us begin with the portion of space nearest to us, within which the parallaxes of stars are determinable. The successful determination of stellar parallax by Bessel, Struve and Henderson in 1838 was a landmark in sidereal astronomy. The distances of three separate stars were successfully measured, and for the first time the sounding line which astronomers had for centuries been throwing into space touched bottom. The employment of the heliometer which Bessel introduced was the main source of our knowledge of the distances of stars until the end of the nineteenth century, and resulted in fairly satisfactory determination of the parallaxes of nearly one hundred stars. For the part of space nearest to us this survey is sufficiently complete for us to infer the average distances of the stars from one another—2½ to 3 parsecs. The parallax determinations of double stars of known orbits lead to the result that the masses of stars have not a very great range, but lie between forty times and one tenth of the mass of the sun.

When the absolute luminosities of the stars the distances of which have been measured are calculated, it is found that, unlike the masses, they exhibit a very great range. For example, Sirius radiates forty-eight times as much light as the sun, and Groombridge thirty-four only one hundredth part. This does not represent anything like the complete range, and Canopus, for example, may be ten thousand times as luminous as the sun. But among the stars near the solar system, the absolute luminosity appears to vary with the type of spectrum. Thus Sirius, of type A, a blue hydrogen star, is forty-eight times as luminous as the sun; Procyon of type F_5—bluer than the sun, but not so blue as Sirius—ten times; α Centauri, which is nearly of solar type, is twice as luminous. 61 Cygni of type K_5—redder than the sun—one tenth as luminous; while the still redder star of type Ma, Gr 34, is only one hundredth as luminous. In the neighborhood of the solar system one third of the stars are more luminous and two thirds less luminous than the sun. The luminosity decreases as the type of spectrum changes from A to M, *i. e.*, from the blue stars to the red stars.

These three results as to the density in space, the mass, and the luminosity have been derived from a very small number of stars. They show the great value of accurate determinations of stellar parallax. So soon as the parallax is known, all the other observational data are immediately utilizable. At the commencement of the present century the parallaxes of perhaps eighty stars were known with tolerable accuracy. Happily the number is now rapidly increasing by the use of photographic methods. Within the last year or two, the parallaxes of nearly two hundred stars have been determined and published. This year a committee of the American Astronomical Society, under the presidency of Professor Schlesinger, has been formed to coordinate the work of six or seven American and one or two English observatories. The combined program contains 1,100 stars, of which 400 are being measured by more than one observatory. We may expect results at the rate of two hundred a year, and

may therefore hope for a rapid increase of our knowledge of the stars within our immediate neighborhood.

VELOCITIES IN THE LINE OF SIGHT

The determination of radial velocities was initiated by Huggins in the early 'sixties, but trustworthy results were not obtained until photographic methods were introduced by Vogel in 1890. Since that time further increase in accuracy has been made, and the velocity of a bright star with sharp lines is determinable (apart from a systematic error not wholly explained) with an accuracy of ¼ kilometer per second. As the average velocities of these stars are between 10 and 20 kilometers a second, the proportional accuracy is of a higher order than can be generally obtained in parallax determinations or in other data of sidereal astronomy. A number of observatories in the United States and Europe, as well as in South America, the Cape, and Canada, are engaged in this work. Especially at the Lick Observatory under Professor Campbell's direction, the combination of a large telescope, a well-designed spectroscope and excellent climatic conditions have been utilized to carry out a bold program. At that observatory, with an offshoot at Cerro San Christobal in Chile, for the observation of stars in the southern hemisphere, the velocities of 1,200 of the brightest stars in the sky have been determined. Among the results achieved is a determination of the direction and amount of the solar motion. The direction serves to confirm the results from proper motions, but the velocity is only obtainable accurately by this method. This quantity, which enters as a fundamental constant in nearly all researches dealing with proper motion, is given by Campbell at 19.5 kilometers per second, or 4.1 times the distance of the earth from the sun per annum, though there is some uncertainty arising from a systematic error of unknown origin.

The observations of radial velocities have shown within what limits the velocities of stars lie and have given a general idea of their distribution. The most important result, and one of a somewhat surprising character, is that the mean velocities of stars, the motion of the sun being abstracted, increase with the type of spectrum. Thus the stars of type B, the helium stars, the stars of the highest temperature, have average radial velocities of only 6.5 kilometers per second; the hydrogen stars of type A have average velocities of 11 kilometers per second; the solar stars of 15 kilometers per second; while for red stars of types K and M it has increased slightly more to 17 kilometers per second. Further, the few planetary nebulæ—*i. e.*, condensed nebulæ with bright line spectra—have average velocities of 25 kilometers per second. There can be no question of the substantial accuracy of these results, as they are closely confirmed by discussions of proper motions. They are, however, very difficult to understand. On the face of it, there does not seem any reason why stars of a high temperature should have specially high velocities. A suggestion has been thrown out by Dr. Halm that as the helium stars have greater masses, these results are in accordance with an equi-partition of energy. But the distances of stars apart is so great that it seems impossible that this could be brought about by their interaction. Professor Eddington suggests that the velocities may be an indication of the part of space at which the stars were formed (*e. g.*, stars of small mass in outlying portions), and represents the kinetic energy they have acquired in arriving at their present positions.

The stars the radial velocities of which have been determined are, generally speak-

ing, brighter than the fifth magnitude, Fainter stars are now being observed. At the Mount Wilson Observatory, Professor Adams has determined the velocities of stars of known parallaxes, as there are great advantages in obtaining complete data for stars where possible. Extension of line-of-sight determinations to fainter stars is sure to bring a harvest of useful results, and a number of great telescopes are engaged, and others will shortly join in this important work.

PROPER MOTIONS

As proper motions are determined by the comparison of the positions of stars at two different epochs, they get to be known with constantly increasing accuracy as the time interval increases. The stars visible to the naked eye in the northern hemisphere were accurately observed by Bradley in 1755. Many thousands of observations of faint stars down to about 9.0 m. were made in the first half of the nineteenth century. An extensive scheme of reobservation was carried out about 1875 under the auspices of the Astronomische Gesellschaft. A great deal of reobservation of stars brighter than the ninth magnitude has been made this century in connection with the photographic survey of the heavens. For the bright stars all available material has been utilized and their proper motions have been well determined, and for the fainter stars this is being gradually accomplished.

Proper motions differ widely and irregularly in amount and direction. Herschel observed a tendency of a few stars to move towards one point of the sky, and attributed this sign of regularity to a movement of the solar system in the opposite direction. But puzzling differences given by different methods remained unexplained until the difficulty was resolved by Professor Kapteyn in a paper read before this section of the British Association at its meeting in South Africa ten years ago. He showed that the proper motions had a general tendency towards two different points of the sky and not towards one only, as would be expected if the motions of the stars themselves were haphazard, but viewed from a point in rapid motion. He concluded from this that there was a general tendency of the stars to stream in two opposite directions. It is interesting to notice that this great discovery was made by a simple graphical examination of the proper motions of stars in different regions of the sky, after the author had spent much time in examining and criticizing the different methods which had been adopted for the determination of the direction of the solar motion. The subject was brought into a clearer and more exact shape by the analytical formulation given to it by Professor Eddington, and after him by Professor Schwarzschild.

This star-streaming is corroborated by observations of velocities in the line of sight. It applies—with the exception of the helium stars—to all stars which are near enough for their proper motions to be determinable. We may say with certainty that it extends to stars at distances of two or three hundred parsecs; it may extend much further, but I do not think we have at present much evidence of this. Professor Turner pointed out that the convergence of proper motions did not necessarily imply movements in parallel directions, and suggested that the star-streams were movements of stars to and from a center. The agreement of the radial velocities with the proper motions seems to me to be opposed to this suggestion, and to show that star-streaming indicates approximate parallelism in two opposite directions in the motions of the stars examined. As the great majority of these stars are comparatively near to us, it is possible that this parallelism is mainly confined to them, and indicates the general directions

of the orbital motions of stars in the neighborhood. An attempted explanation on these lines, as on Professor Turner's, implies that the sun is some distance from the center of the stellar system.

A discovery of an entirely different character was made by Professor Boss in 1908. He spent many years in constructing a great catalogue giving the most accurate positions and motions of 6,200 stars obtainable from all existing observations. This catalogue, which was published by the Carnegie Institution, was intended as a preliminary to a still larger one which would give the accurate positions and motions of all the stars down to the seventh magnitude. In the course of this work Professor Boss found that forty or fifty stars scattered over a considerable region of the sky near the constellation Taurus were all moving towards the same point in the sky and with nearly the same angular velocity. He inferred that these stars were all moving in parallel directions with an equal linear velocity, and the supposition was verified, in the case of several of them, by the determination of their radial velocities. From these data he was able to derive the distance of each star and thus its position in space. The existence of a large group of stars, separated from one another by great distances, and all having the same motion in space, is a very remarkable phenomenon. It shows, as was pointed out by Professor Eddington, how small is the gravitational action of one star on another, and that the movement of each star is determined by the total attraction of the whole mass of the stars. Several other interesting moving clusters have been found since. For all the stars belonging to these clusters, the distances have been found, and from them luminosities and velocities of individual stars, particulars which are generally only obtainable for stars much nearer to us.

Proper motions are the main source of our knowledge of the distances of stars which are beyond the reach of determination by annual parallax. If a star were known to be at rest its distance could be calculated from the shift of its apparent position caused by the translation of the solar motion. As the solar system moves 410 times the distance of the earth from the sun in a century, this gives a displacement of 1" for a star at the distance of 500 parsecs. This method has been applied by Kapteyn to determine the distances of the helium stars, as their velocities are sufficiently small to be neglected in comparison with that of the solar system. But generally it is only possible to find the mean distances of groups of stars of such size that it may be assumed that the peculiar motions neutralize one another in the mean. For example, the average distance of stars of type A, or stars of the fifth magnitude, or any other group desired may be found. In this way Kapteyn has found from the Bradley stars that the mean parallax of stars of magnitude m is given by the formula

$$\log. \pi_m = -1.108 - 0.125\, m.$$

In conjunction with another observational law which expresses the number of stars as a function of the magnitude, this leads to a determination of the density of stars in space at different distances from us, and also of the "luminosity law," *i. e.*, the percentage of stars of different absolute brightness. Professors Seeliger and Kapteyn have shown in this way that there is a considerable falling off of star-density as we go further from the solar system. It seems to me very necessary that this should be investigated in greater detail for different parts of the sky separately. A general mathematical solution of general questions which arise in the treatment of astronom-

ical statistics has been given by Professor Schwarzschild. His investigations are of the greatest value in showing the exact dependence of the density, luminosity and velocity laws on the statistical facts which can be collected from observation. The many interesting statistical studies which have been made are liable to be rather bewildering without the guidance furnished by a general mathematical survey of the whole position.

When the proper motions are considered in relation to the spectral types of the stars, the small average velocities of the hydrogen stars and still smaller ones of the helium stars found from line-of-sight observations are confirmed. If stars up to a definite limit of apparent magnitude, say, to 6.0 m., or between certain limits, say 8.0 m. and 9.0 m., are considered, then the solar stars are found to be much nearer than either the red or the blue stars. Thus both red and blue stars must be of greater intrinsic luminosity than the solar stars. As regards blue stars, this agrees with results given by parallax observations. But the red stars appear to consist of two classes, one of great and one of feeble luminosity, and it does not seem that a sufficient explanation is given by the fact that a selection of stars brighter than any given apparent magnitude will include the very luminous stars which are at a great distance, but only such stars of feeble luminosity as are very near.

The significance of these facts was pointed out by Professor Hertzsprung and Professor Russell. They have a very important bearing on the question of stellar evolution, a subject for discussion at a later meeting this week. From the geometrical point of view of my address these facts are of importance in that they help to classify the extraordinarily large range found in the luminosities of stars. Putting the matter somewhat broadly, the A stars, or hydrogen stars, are on the average intrinsically 5 magnitudes brighter than the sun, whilst the range in their magnitudes is such that half of them are within ¾ magnitude of the mean value. The stars of type M, very red stars, are of two classes. Some of them are as luminous as the A stars, and have a similar range about a mean value 5 magnitudes brighter than the sun. Others, on the contrary, have a mean intrinsic brightness 5 magnitudes fainter than the sun and with the same probable deviation of ¾ magnitude. Between the types M and A there are two classes the distance apart of which diminishes as the stars become bluer. The facts in support of this contention are very forcibly presented by Professor Russell in *Nature* in May, 1914. If this hypothesis is true, and it seems to me there is much to be said in its favor, then the apparent magnitude combined with the type of spectrum will give a very fair approximation to the distances of stars which are too far away for their proper motions to be determinable with accuracy.

In dealing with the proper motions of the brighter stars, the sky has been considered as a whole. Now that the direction and amount of the solar motion are known, we may hope that, as more proper motions become available, the different parts of the sky will be studied separately. In this way we shall obtain more detailed knowledge of the streaming, and also of the mean distances of stars of different magnitudes in all parts of the sky, leading to a determination of how the density of stars in space changes in different directions. A second line of research which may be expected to give important results is in the relationship of proper motions to spectral type. There is in preparation at Harvard College by Miss Cannon, under Professor Pickering's direction, a catalogue giving the type of

spectrum of every star brighter than the ninth magnitude. It would be very desirable to determine the proper motions of all these stars. If all the material available is examined it should be possible to do this to a very large extent.

PHOTOMETRY AND COLOR

For the more distant parts of the heavens proper motions are an uncertain guide, and we must depend on what can be learned from the light of the stars by means of stellar photometry, determinations of color, and studies of stellar spectra. Speaking generally, we attempt to discover from the nearer stars sufficient about their intrinsic luminosities to enable us to use the apparent magnitude as an index of the distances of the stars which are further away. The most striking example is found in Professor Hertzsprung's determination of the distance of the small Magellanic cloud. From a knowledge of the characteristics of the Cepheid variables found in this cloud by Miss Leavitt, and their apparent magnitude, he deduced the distance of the cloud as 10,000 parsecs.

Much attention has been given of late years to stellar photometry. In 1899 Professor Pickering published the Revised Harvard Photometry giving the magnitudes of all stars brighter than 6.5 m. In 1907 Messrs. Müller and Kempf completed a determination of 14,199 stars of the northern hemisphere brighter than 7.5 m. In 1908 a catalogue of 36,682 stars fainter than 6.5 m. was published at Harvard. These determinations derive additional importance as they give the means of standardizing estimates of magnitude made by eye, particularly the many thousands of the Bonn Durchmusterung.

By the labors of Professor Pickering and his colleagues at Harvard, Professor Schwarzschild, Professor Parkhurst at Yerkes, Professor Seares at Mount Wilson, and others, the determinations of the magnitudes of stars by photography has made rapid strides. As yet no complete catalogues of photographic magnitude corresponding to the Revised Harvard Photometry have been published, though considerable parts of the sky and special areas, such as the Pleiades, have been carefully studied. The determination of the photographic magnitudes of any stars which may be required is, however, a comparatively simple matter when the magnitudes of sufficient standard stars have been found. A trustworthy and uniform scale has been to a large extent secured by the use of extra-focal images, gratings and screens in front of the object glass, and the study of the effects of different apertures and different times of exposure.

At Harvard and Mount Wilson, standard magnitudes of stars near the north pole have been published extending to nearly the twentieth magnitude. In the part of the range extending from 10.0 m. to 16.0 m. these agree very satisfactorily. There is, however, a difference of 0.4 m. in the scale between 6.0 m. and 10.0 m. which needs to be cleared up.

A uniform and accurate scale of magnitude is of fundamental importance in counts of the numbers of stars. Such counts aim at the determination of two things: (1) how the numbers vary in different parts of the sky, and (2) what is the ratio of the number of stars of each magnitude to that of the preceding magnitude in the same area of the sky. The counts of stars from the gauges of Sir William and Sir John Herschel, those of the stars contained in the Bonn Durchmusterung, those made by Professor Celoria, and the recent counts of the Franklin-Adams plates by Dr. Chapman and Mr. Melotte, all agree in showing a continuous increase of stars as we proceed

from the pole of the galaxy to the galaxy itself. The importance of this fact is that it shows a close connection between the Milky Way and the stars nearer to us. The Milky Way is not a system of stars beyond the others, but is the primary feature of our "island universe."

Photometric observations have acquired additional importance from the differences between photographic and visual magnitudes. The ordinary plate is more sensitive to blue light than the eye, and the difference between the photographic and visual (or photo-visual) magnitude of a star is an index of the color. The color index is found by observation to be related very closely to the type of spectrum. Professor Seares has shown from the color indices that as the stars become fainter they become progressively redder. Professor Hertzsprung has found the same thing by the use of a grating in front of the object glass. Among stars of 17.0 m. visual magnitude, Seares found none with a color index less than 0.7; this is approximately the color index of a star of solar type, *i. e.*, near the middle of the range from blue stars to red stars.

There are three ways in which this may occur. The stars may be bright but very distant red stars; or they may be faint red stars, like those in the immediate neighborhood of the sun; or there may have been an absorption of blue light. It is not possible to say in what proportion these causes have contributed. The red stars of 9.0 m. and 10.0 m. are nearly all very luminous but distant bodies, but it seems likely that stars of 17.0 m. will contain a greater proportion of stars of small luminosity.

The absorption of light in space is very small, and as yet imperfectly determined. Professor Kapteyn and Mr. Jones, by comparing the color indices of stars of large and small proper motion, make the difference between the absorption of photographic and visual light as 1 m. in 2,000 parsecs. The question has been examined directly by Professor Adams, who has obtained spectra of near and distant stars which are identical as regards their lines, and has examined the distribution of the continuous light. This direct method of comparison showed that the more distant star was always weaker in violet light. But as both these investigations show that very luminous stars are intrinsically somewhat bluer than less luminous stars of the same spectral type, the two causes require further research for their disentanglement. The question is of importance, as it may serve in some cases to determine the distances of very remote bodies the type of spectrum of which is known.

It must be admitted that we are as yet very ignorant of the more distant parts of the "island universe." For example, we can make little more than guesses at the distance of the Milky Way, or say what part is nearest to us, what are its movements, and so on. But, nevertheless, the whole subject of the construction of the heavens has been opened up in a remarkable manner in the last few years. The methods now employed seem competent to produce a tolerably good model showing the coordinates and velocities of the stars as well as their effective temperatures and the amount of light they radiate. Industry in the collection of accurate data is required, along with constant attempts to interpret them as they are collected. The more accurate and detailed our knowledge of the stellar system as it is now, the better will be our position for the dynamical and physical study of its history and evolution.

F. W. Dyson

The Royal Observatory,
Greenwich

A NEW PROFESSION

The following extracts from a paper entitled "Applied Biology, A New Profession," emphasizing the opportunities for men in sanitary engineering, public health work and municipal engineering was read before the Civil and Sanitary Engineering Section of the Alumni Convention at Pittsburgh, February 20, and the complete article can be found in the reports of the convention.

With increasing urbanization caused by the flux from the country districts to the cities and all the results which accrue from the consequent overcrowding and the extension to a greater number of people of an artificial mode of living, the chances for morbidity and mortality are greatly increased. To offset these conditions and to minimize these dangers, there has grown up in the last quarter century a new profession, sanitary science or preventive medicine, concerned with the prevention and control of disease rather than with cure, and as the proverbial "ounce of prevention" is still "worth a pound of cure" and as the increase of perplexing problems, which are the outgrowth of these constantly extending artificial conditions, is apparent, the new profession would be justified even if the brilliant deeds it has accomplished, during the few years it has been in existence, were unknown. Those of you who are interested in this work know of many instances in your own experience to corroborate my assertion. That this new field is entirely distinct from that of curative medicine and that it contains many problems which the ordinary physician is not fitted either by training or by experience to solve, is proved by the fact that our more progressive medical schools are offering a three-year post-graduate course to their students, in order that they may be properly qualified to cope with the problems of sanitary science.

The following extract from the health bulletin of one of our most progressive states further emphasizes this point. "The practise often followed of naming the leading practitioner as health officer is by no means indicative of a good choice. It is probably more often the reverse. A physician becomes a competent practitioner only after intelligent and arduous study of curative measures. The more successful he is the more he has specialized in his chosen work to the exclusion of those particular sciences that have to do with preventive measures."

. . . .

For those of you who are interested chiefly in the engineering side of public health work, it is desirable to review the applications of biology to sanitary science, in order to make clear the great number of points at which this subject touches the welfare of humanity. There is, perhaps, no better way of doing this than by examining the curriculum of that institution which was a pioneer in this field and noting the practical applications of the various subjects therein contained.

First and foremost in this curriculum comes the course in general biology, which is the study of the physics and chemistry of living matter, and if our thesis is that we are trying to improve human living conditions and better the environment of mankind in general, what better way is there of approaching a solution of this difficult problem than by studying the simpler forms and their correspondingly simpler reactions to changes in their environment? And what subject more fundamental could be imagined than that one, which from its very name means the study of living things?

. . . .

An independent piece of research work, a thesis, is also required and this tends to develop the resourcefulness of the individual when he is thrown upon his own responsibility. To the pragmatist, who claims that the work of the investigator in pure science has no practical value, it is but necessary to point out there is only a very little research that sooner or later does not meet with a practical application; the pure science of to-day becoming the applied science of to-morrow. On completion of this course, the student in biology has a four-fold possibility before him: first, openings in the various fields of public health work; second, positions in the fermentation industries; third, teaching positions, either in biology or its practical applications; fourth, an opportunity to build upon this excellent foundation a medical education.

. . . .

The supply of persons properly trained to teach biology, especially its applications to public health work and of those adequately equipped to occupy field positions, is far below the demand. One finds in many of these positions, incompetent men; men who are not fitted by either training or experience to solve problems related to the public health in a sound, rational, scientific manner, but who work by some rule of thumb method or dispose of their problems in a manner similar to that of the alchemists of the middle ages. It is true

that there are many unsolved questions in this nearly virgin field, and because of this and for the further reason that our cities still continue to enlarge, thus increasing our needs for sanitation, the opportunities in this field, especially in our rapidly growing west and middle west, are legion and because of these facts advance in most of the positions is comparatively rapid. This training enables a person to guide in a scientific manner such important movements as tuberculosis control, the establishment of milk depots, school inspection, the proper collection of vital statistics, proper housing, public health organization, in fact any question dealing with or intimately associated with matters pertaining to the conservation of life.

In this new field, we find sanitary biologists, sanitary engineers and sanitary chemists working together for a solution of such problems as providing a safe water supply and sewerage system, controlling epidemics of disease, enforcing proper care in the handling of food materials, in short, attempting the best solution of the particular public health problems which confront any given community.

. . . .

There is no subject of greater interest to people in general than that of their own health and they recognize that this is closely related to questions of public health, for on the subject of disease and death we all meet on common ground. Because of this interest, the subject is much discussed, and it is not surprising to find much misinformation afloat because persons often appoint themselves authority pro-tem in social gatherings, and give decisions which have no background of fact or wisdom. A short time ago I heard from a reliable source that a man in a public health position said that typhoid carriers could be detected by blood cultures and from another "authority" same the statement that a T-bone steak, in the bottom of a well, was responsible for an outbreak of typhoid fever which occurred in the community in which the well was situated. Later I received a graphic description of how hordes of typhoid germs sallied forth from the carcass of a horse which was in a river bed, and calmly awaited unsuspecting persons drinking from the stream.

Unscrupulous persons, either in their desire for publicity or in order to "grind an axe" of their own, take advantage of this desire on the part of the public to be informed on health matters, by uttering half-truths or deliberately trifling with facts, to such an extent that wrong ideas gain ground and it takes much time to eradicate these false impressions. By such unscrupulous persons, the march of progress is materially hindered. Politicians and others with no knowledge of public health matters and not appreciating the gravity of their deeds sometimes depose good men or so curtail their powers that they are unable to discharge their duties efficiently or to serve the best interests of the community.

. . . .

It is over a half century since the theory of spontaneous generation or abiogenesis was finally overthrown, and while no one at the present time believes that eels can arise de novo from mud and slime or that mice can be generated from dirty flannel and corn, the idea is still current that decaying material and the consequent evil odors; poor plumbing; the "catching" of cold; etc., per se provide a suitable environment for generating disease-producing microorganisms. Nothing could be further from the truth, for a study of biology teaches us that between the living and non-living world we have one of the best defined barriers in nature, and that no living material, not even the humblest bacterial cell, comes into existence without the intervention of preexisting life of the same type.

Again quoting from one of our monthly state health bulletins: "Removing health departments from politics; selecting the right man, paying him the right salary, and permanent tenure of the position will do much to correct existing evils. There is no official of more importance to any community than a conscientious and capable health officer. The conserver of the health of our people is a benefactor of the race and worthy of the highest honors in the gift of the state."

. . . .

In closing allow me to quote Disraeli and express my strong sympathy with his ideas: "The public health is the foundation on which reposes the happiness of the people and the power of the country. The care of the public health is the first duty of a statesman."

J. E. RUSH

DEPT. OF BIOLOGY AND PUBLIC HEALTH,
CARNEGIE INSTITUTE OF TECHNOLOGY

THE SECOND PAN-AMERICAN SCIENTIFIC CONGRESS AND ITS SECTION OF ANTHROPOLOGY

IN accordance with the resolutions of the First Pan-American Scientific Congress, held in Santiago, Chile, December 25, 1908, to

January 5, 1909, a Second Pan-American Scientific Congress will meet in Washington next December under the auspices of the government of the United States. The congress will open on Monday, December 27, 1915, and adjourn on Saturday, January 8, 1916.

The executive committee of the congress is as follows:

William Phillips, A.B., third assistant secretary of state, chairman *ex-officio*.

James Brown Scott, J.U.D., secretary, Carnegie Endowment for International Peace, vice chairman.

William H. Welch, M.D., LL.D., president, National Academy of Sciences, honorary vice chairman.

John Barrett, LL.D., director general, Pan-American Union.

W. H. Bixby, Brigadier General, U. S. A., retired.

Philander P. Claxton, LL.D., commissioner of education.

William C. Gorgas, M.D., Sc.D., surgeon general, U. S. A.

William H. Holmes, B.S., head curator, Smithsonian Institution.

Hennen Jennings, C.E., former president, London Institution Mining and Metallurgy.

George M. Rommel, B.S., chief, Animal Husbandry Division, Bureau of Animal Industry, Department of Agriculture.

L. S. Rowe, Ph.D., president, American Academy of Political and Social Science.

Robert S. Woodward, Ph.D., president, Carnegie Institution of Washington.

The organization officers are:

John Barrett, LL.D., secretary general.

Glen Levin Swiggett, Ph.D., assistant secretary general.

The headquarters are at the Pan-American Union, Washington, D. C.

The Pan-American Scientific Congress had its origin in the scientific congresses that had been held by the republics of Latin America prior to the congress in Santiago, and was established with the generous conviction that the United States should share in their undertaking. This conviction was splendidly shown in the unsolicited and voluntary action of the first congress in the selection of Washington as the place of meeting of the second congress, the main purpose of which will be to increase the exchange of knowledge and bring about a better understanding of the ways in which the several republics can work to the advancement of science, the increase of culture and the promotion of trade, commerce and mutual helpfulness. In view of the fact that this second congress is to be held under the auspices of the government of the United States, it is earnestly hoped that our foremost scientists, learned societies and educational institutions will cooperate in every way possible in order to insure the success of the congress.

The nine main sections of the program of the congress, with the name of the chairman in charge of each section, are as follows:

I. Anthropology, Mr. William H. Holmes.
II. Astronomy, Meteorology and Seismology, Mr. Robert S. Woodward.
III. Conservation of Natural Resources, Agriculture, Irrigation and Forestry, Mr. George M. Rommel.
IV. Education, Mr. P. P. Claxton.
V. Engineering, General W. H. Bixby.
VI. International Law, Public Law and Jurisprudence, Mr. James Brown Scott.
VII. Mining and Metallurgy, Economic Geology and Applied Chemistry, Mr. Hennen Jennings.
VIII. Public Health and Medical Science, General Wm. C. Gorgas.
IX. Transportation, Commerce, Finance and Taxation, Mr. L. S. Rowe.

Each section is divided further into subsections. There are forty-five of the latter in all, each with a special committee and program. The deliberations of the congress will be based, in consequence, according to the subject-matter to be discussed in the various sub-sections. In addition to the general sessions of the congress, there will be joint sessions between the different sections and subsections. Several of the leading national associations of the United States, concerned with the investigation of subjects of pertinent interest to some of the sections of the congress, have received and accepted invitations from the executive committee of the Second Pan-American Scientific Congress to meet in Washington at the same time and hold one or more

joint sessions with a section or sub-section of corresponding interest.

The following persons will be members of the congress:

The official delegates of the countries represented.

The representatives of the universities, institutes, societies and scientific bodies of the countries represented.

Such persons in the countries participating in the congress as may be invited by the executive committee, with the approval of the countries represented.

All writers of papers.

All members of the congress shall be entitled to attend its sessions, to take part in the debates, and to receive a copy of such publications as the executive committee may issue. There will be no membership fee of any character.

The interest throughout Latin America for the congress is steadily growing. The executive committee is assured that all of these countries appreciate deeply the active preparations now being made in Washington for a successful meeting, and will avail themselves generously of this great opportunity for Pan-American solidarity of action in intellectual interests. Each of the participating Latin American countries, eighteen in number, has been invited to appoint a committee to coöperate with the executive committee of the congress and to make such arrangements as will insure the most generous participation of each country in the congress through the attendance of delegates and representation on the program. A feature of particular importance and appealing interest to the Latin American countries is that of the special Pan-American topics which will be discussed at the time of the congress in a series of conferences. The various sections of the congress, and in some cases the different sub-sections, have designated certain topics to be discussed in this manner. Each country has been invited to select its most eminent writers to prepare papers on these topics, one person for each topic.

Section I will discuss such subjects as relate to the origin, development and distribution of mankind into ethnic, social and political groups. Of particular interest are the topics which refer to the chronology of the American race and the evolution of its culture, and the complex of races and nationalities now constituting the Pan-American populations.

The chairman of this section is Mr. William Henry Holmes, head curator of anthropology, United States National Museum. Mr. Holmes is a member of the leading national and foreign societies devoted to research in the fields of archeology and anthropology. He was a delegate to the First Pan-American Scientific Congress, which met in Santiago, Chile, in 1908. Dr. Ales Hrdlicka, curator of the division of physical anthropology, United States National Museum, is the secretary of this section.

In addition to the chairman and the secretary, the committee in charge of the program of Section I includes the following representatives of important institutions, societies and other organizations devoted in whole or in part to the science of man:

F. W. Hodge, of the Bureau of American Ethnology, Smithsonian Institution.

Walter Hough, of the United States National Museum.

J. Walter Fewkes, of the National Academy of Sciences.

Roland B. Dixon, of Harvard University.

C. C. Willoughby, of the Peabody Museum of American Archeology and Ethnology, Harvard University.

George B. Gordon, of the University of Pennsylvania.

Frederick Starr, of the University of Chicago.

Albert Ernest Jenks, of the University of Minnesota.

Franz Boas, of Columbia University.

Hiram Bingham, of Yale University.

Warren K. Moorehead, of the Phillips Academy Museum, Andover, Mass.

A. L. Kroeber, of the University of California.

Elizabeth Duncan Putnam, of the Davenport Academy of Sciences, Davenport, Iowa.

Alice C. Fletcher, of the Archeological Institute of America.

Stewart Culin, of the Museum of the Brooklyn Institute of Arts and Sciences.

M. H. Saville, of the Heye Museum, New York.

S. A. Barrett, of the Milwaukee Public Museum.

George A. Dorsey, of the Field Museum of Natural History.

Arthur C. Parker, of the Museum of the State of New York.

C. F. Lummis, of the Southwest Museum, Los Angeles.

George Grant MacCurdy, of the Yale University Museum.

John R. Swanton, of the Anthropological Society of Washington.

T. Mitchell Prudden, of the American Ethnological Society, New York.

Clark Wissler, of the American Museum of Natural History, New York.

Pliny E. Goddard, of the American Folk-Lore Society.

Waldo Lincoln, of the American Antiquarian Society.

Sylvanus G. Morley, of the Carnegie Institution.

Edgar L. Hewett, of the School of American Archeology.

H. M. Whelpley, of the Missouri Historical Society.

J. C. Branner, of Leland Stanford Junior University.

Mr. W. C. Mills, of the Ohio State University.

For this section some of the most distinguished scientists in Pan-America have been invited to prepare papers on the subjects described in the preliminary program, edition of April 15, a copy of which may be obtained on request to the secretary general of the congress.

The following topic has been proposed by Section I for the series of Pan-American conferences: "The desirability of uniform laws throughout the Pan-American countries for the protection of antiquities, the systematic promotion of anthropological research and the collection and scientific treatment of museum materials."

The Nineteenth International Congress of Americanists will meet in Washington during the same week with the Pan-American Scientific Congress, and joint conferences will be held for the discussion of subjects of common interest to members of the two organizations. This will be especially advantageous, since a large number of students from all parts of America, as well as from the Old World, interested in these branches, will thus be brought together on common ground.

Glen Levin Swiggett,
Assistant Secretary General

SCIENTIFIC NOTES AND NEWS

At the Manchester meeting of the British Association for the Advancement of Science, Sir Arthur J. Evans, F.R.S., the archeologist, honorary keeper of the Ashmolean Museum, Oxford, was elected president for next year's meeting, to be held at Newcastle-on-Tyne. The meeting of 1917 will be held at Bournemouth.

A. Gibb Maitland, director of the geological Survey, Western Australia, has been elected president of the Royal Society of Western Australia for the ensuing session.

The International Engineering Congress met at San Francisco from September 20 to 25. Major-general G. W. Goethals, honorary president of the congress, delivered the principal address.

The office of state entomologist has recently been established in Wisconsin, to take over the nursery and orchard inspection and administration of the laws governing insecticides and fungicides. It is to be independent of the University of Wisconsin, with headquarters in the state capitol at Madison. Professor J. G. Sanders goes from the College of Agriculture to be the first incumbent of the office and Dr. S. B. Fracker, instructor in the same department, has been appointed assistant entomologist.

Professor Ewald Hering, the eminent physiologist of Leipzig University, will retire at the close of the winter semester.

Dr. Charles K. Mills has resigned from the medical faculty of the University of Pennsylvania, where since 1893 he had been professor of mental diseases and of neurology.

Professor Anthony Zeleny, of the University of Minnesota, has this year leave of absence and will spend the time in research in physics at Princeton University.

THE Detroit board of health has been authorized to employ a laboratory expert as head of the Pasteur Institute and J. B. Kelly, Ann Arbor, has been elected to the position.

MR. F. A. FENTON, a graduate student of the University of Wisconsin and for a time deputy nursery inspector in the same state, has joined the Federal Bureau of Entomology and will be engaged in work with Mr. J. J. Davis at Lafayette, Indiana.

DR. N. ANNANDALE, superintendent of the Indian Museum, Calcutta, is to spend the greater part of a six months' leave of absence in Siam and Japan, studying the fauna of the lake regions.

WE learn from *Nature* that in commemoration of Captain Cook, a tablet has been placed on the school at Great Ayton, Cleveland, where the navigator received his education; a scholarship has also been established at Marton, in the same neighborhood, which was Captain Cook's birthplace. The cost of both has been provided out of the surplus of the fund raised for the erection of the Cook memorial in London.

DR. AUSTIN FLINT, a distinguished physician and alienist of New York City, long professor of physiology in the Bellevue Hospital Medical College and the Medical College of Cornell University, died on September 22, at the age of seventy-nine years.

DR. H. H. MCGREGOR, formerly instructor in chemistry, Adelbert College, and recently appointed instructor in biochemistry at the medical school, Western Reserve University, has died of typhoid fever in Toronto, Canada.

BESIDES the biological expedition to British Honduras, mentioned in these columns, the St. Louis University had a geological expedition in the field during the summer months. The personnel of the latter was Professors W. H. Agnew, J. Knipscher, H. F. Sloctemyer, J. A. Krance, A. H. Poetker, J. B. Macelwane, of the St. Louis University; Professors P. J. Troy and T. J. Motherway, of St. Mary's College, St. Marys, Kan.; Professor J. A. Kilian, of St. John's University, Toledo, Ohio, and Professor R. E. Connolly, of Campion College, Prairie du Chien, Wis. The task assigned to the party was a threefold one. They were to undertake a preliminary study of the petrified forests of eastern Arizona; to investigate a number of structural and stratigraphic details in the Bright Angel Quadrangle of the Grand Canyon of the Colorado; and, after visiting several points of geologic interest on the Pacific coast, to make a general reconnaissance of the Pre-Cambrian, Cambrian and Pleistocene geology of parts of the Cordillera along the Canadian Pacific Railway. The members of the party secured a considerable quantity of valuable material from each of these regions, including a collection of Middle Cambrian trilobites and brachiopods from Mts. Stephen and Field. They also obtained a larger number of excellent photographs for laboratory and class-room illustration.

MR. W. J. WINTEMBERG, of the Geological Survey, Ottawa, has returned from a successful archeological exploration at the prehistoric Iroquoian site near Roebuck, Ontario. He succeeded in mapping the traces of a palisade across the farm of Nathaniel White which, because it was under crop, was not excavated by Mr. Wintemberg in 1912 when he explored the greater part of the Roebuck site. This season's exploration also resulted in securing thirty-three human skeletons and eleven boxes of objects made by the prehistoric people of the place. Many of the skeletons were photographed in situ. Several of these skeletons show conclusively that the people suffered from terrible diseases which caused growths upon the bones, and the abnormal union of certain bones. Their teeth also gave them great trouble. Among the important specimens found were an unfinished comb made of antler and two barbed fish hooks made of bone. Many fragments of pottery and of pipes made of pottery were also found. Some of the latter are sculptured to represent the human face and are of artistic merit.

UNIVERSITY AND EDUCATIONAL NEWS

THE board of trustees of the Ohio State University, Columbus, has authorized the establishment of a department of public health

and sanitation, which has been organized with the following appointments: Eugene M. McCampbell, M.D., professor of preventive medicine and head of the department; Robert G. Patterson, A.B., A.M., assistant professor of public health; Emery R. Hayhurst, M.D., assistant professor of industrial hygiene; William H. Dittoe, C. E., instructor in public health engineering; Frank G. Boudreau, M.D., instructor in public health and sanitation; Lear H. Van Buskirk, B.Sc., instructor in public health laboratory methods.

THE following appointments have been made to the faculty of Case School of Applied Science: Keith F. Adamson, the University of Pennsylvania, assistant professor of mechanical engineering; Melville F. Coolbaugh, the South Dakota School of Mines, assistant professor of chemistry; Roy E. Spencer, Harvard University, instructor in English; Lawrence G. Wesson, Harvard University, instructor in organic chemistry; Carl H. Wilson, Harvard University, instructor in chemistry; Arthur E. Bradley, recently of Cornell University, instructor in civil engineering; Allan A. Prior, Harvard University, instructor in electrical engineering; Perry F. Ellsworth, the Edison Electric Company, instructor in electricity and drawing; R. B. Reis, the Westinghouse Electric Company, instructor in mechanical engineering; H. F. Pasini, graduate of the Y. M. C. A. Training School of Springfield, director of the gymnasium; Bohlis Dahlman, instructor in gymnastics.

PROFESSOR H. F. WILSON, of Oregon State College, has gone to the University of Wisconsin as professor of economic entomology to take the place of Professor J. G. Sanders, who has become state entomologist for Wisconsin.

DR. R. G. PEARCE, associate in physiology, Western Reserve University, has been appointed assistant professor of physiology in the college of medicine, University of Illinois, Chicago.

DR. JAMES CRAIG NEEL has been appointed instructor in obstetrics and gynecology (on an academic basis) in the University of California Medical School.

S. H. E. BARRACLOUGH, lecturer at the University of Sydney, has been appointed to the chair of mechanical engineering.

DISCUSSION AND CORRESPONDENCE

A PROPOSED CLASSIFICATION OF THE ATTITUDE OF GEOLOGIC SURFACES

THE familiar classification of folds has long been used by the geologist in working with oil and gas. Its inadequacy for his purposes is apparent when one considers that the determining factor in the gravitational separation of gas, oil and water is not the general plane of the bed, but the actual surface constituting the roof or floor of the reservoir. This may differ from the general plane of the bed due not only to irregularity of deposition, but also to irregularity of cementation, since the reservoir frequently constitutes only a portion of the sandstone bed. A mere classification of folds will not suffice, because it is the upper or the lower surface which concerns us, and they are frequently not parallel.

A lenticular bed which lies in general horizontal is not a fold at all, nor is one lying in a plane monocline. Yet the upper and lower surfaces of either of these have an attitude which is of great moment to the oil geologist, and must be considered along with the folded surfaces.

The following classification of geological surfaces is therefore presented here in the belief that it will be applicable to other geological problems as well as to those of the oil and gas geologist. There are four prime divisions:

1. Acline—no inclination.

2. Monocline—inclination in one general direction.

3. Anticline—inclination away from a point or axis.

4. Syncline—inclination toward a point or axis.

Acline

The acline is of small importance because one finds so generally that there is at least a

slight inclination to beds, either deformational or depositional. The terrace is an acline interrupting a monocline which continues with the same dip direction both above and below the acline.

The horizontal bed is rare because (*a*) beds are generally laid down on a shore which is an inclined surface, and (*b*) when the shore is raised at the time of emergence some tilting will usually result. Even if as a whole it is flat, the upper and lower surfaces are likely to have an inclination because of differences in deposition, compacting or cementation.

Monocline

"Monocline" is a much-abused term. Some authors use it for what Scott more discriminatingly calls a monoclinal *flexure*—"a single sharp bend connecting strata which lie at different levels and often horizontal except along the line of flexure." A more desirable use is that of Grabau, Chamberlain and Salisbury, and the Century Dictionary, who follow the author of the term, H. D. Rogers, in applying it simply to beds "dipping in one direction."

The monocline may be subdivided into three primary types:

1. The plane monocline—all surfaces having a roughly similar degree of dip.

2. The anti-monocline is a curved portion of a monocline which is convex, when seen from a point perpendicular to the general surface and above it. This is a very common structure. It is readily seen that it is analogous to an anticline and would become one if the surface in general were tilted to a more horizontal position. Similarly, an anticline tilted sufficiently becomes an anti-monocline. Orton, with this aspect in mind, called it an "arrested anticline."

3. The syn-monocline is a curved portion of a monocline which is concave when seen from a point perpendicular to the general surface and above it. It bears the same relation to a syncline that the anti-monocline does to the anticline.

4. The monoclinal flexure. In addition to these fundamental units there is the very common combination of an anti-monocline passing directly into a syn-monocline below it. For this the term monoclinal flexure has long been used. To restrict the word monocline to this structure as some geologists have done is very objectionable.

5. Half-fold. This same combination is found in the half-fold, which is the whole surface from the axis of an erect anticline to the axis of an adjoining syncline; or if the anticline springs from a plane, to that plane.

Anticline

Anticlines are divisible into the following classes:

1. The *dome* is a surface dipping outwardly in all directions from a central point or line.

2. The *level axis anticline* is one where the surface is in general horizontal along the axis of the anticline. A very elongate dome may have a middle portion which is also a level axis anticline.

3. The *plunging anticline* is one having the axis itself inclined. An elongate dome is made up of two plunging anticlines, the plunges being in general in opposite directions. As stated above, a level axis anticline may intervene.

4. *Nose.* Two anticlines may cross each other. This generally produces a more or less marked dome at the intersection, which has radiating plunging axes. The anticlines are seldom of equal magnitude. If one of them is very much less than the other, it is seen merely as a wrinkle in the flank of the larger one. Since these are very common and confusion arises if they are called anticlines without qualification, the descriptive name of *nose* is proposed. A *nose* is a relatively minor plunging anticline on the flank of a much larger anticline or syncline or in a monocline. It causes the isobaths to show a mere wave in the down-dip direction.

Synclines

Applying the foregoing distinctions to synclines, we have the opposite terms—*basin, level axis syncline, plunging syncline* and *chute.*

The term *chute*, while new in this connection, is needed. It may be defined as a "minor plunging syncline on the flank of a much larger anticline or syncline or in a monocline." It causes the isobaths to make a wave in the up-dip direction.

Saddles

A saddle is a down fold in the axis of an anticline, or an up fold in the axis of a syncline. This form partakes of the nature of both an anticline and a syncline, as is evident if a model in sheet lead is turned upside down—when we find it is still a saddle, but at right angles to the original one.

For surfaces involved in recumbent, erect, carinate, isoclinal or fan folds, the present fold terms may be used without modification.

The greatly increased use of the geologic surface in economic geology has led to the proposal of this specific set of terms, for which the current nomenclature of folds was not adequate.

ROSWELL H. JOHNSON
UNIVERSITY OF PITTSBURGH

THE ORIGIN OF THE "NITER SPOTS" IN CERTAIN WESTERN SOILS

IN an article entitled "The Origin of the 'Niter Spots' in Certain Western Soils," which appeared in the *Journal* of the American Society of Agronomy, Vol. 6, No. 6, Professors Stewart and Peterson of the Utah Experiment Station state on pages 246, 247 and 248 of the publication cited, that,

> The brown color of the "niter spots" is produced by the solvent and decomposing action of the sodium nitrate upon the organic matter of the soil in just the same way that the black color of the black alkali spots is produced by the solvent and decomposing action of the sodium carbonate upon the soil organic matter. . . .
>
> The color (of the black alkali) is produced by the sodium carbonate, because, being the salt of a weak acid and a strong base, it readily hydrolyzes, producing sodium hydroxide, or caustic soda, which, as is well known, acts on carbohydrates, producing a brown color, the intensity of which depends on the concentration of the sodium or potassium hydroxide, thus readily accounting for the production of the color of black alkali. *Likewise, in the case of sodium or potassium nitrate, the salt being the result of this union of a strong base and a stronger acid than carbonic acid, does not hydrolyze so easily and as a result there is a smaller amount of sodium or potassium hydroxide present and necessarily the production of a milder color as observed in the brown alkali (niter) spots. The sodium and potassium sulphate and chloride, being the salts of strong acids and bases, do not hydrolyse, therefore caustic alkali is not produced, and consequently the color is not produced by these alkali salts.*

It will be seen that while the authors state that the alkali sulphates and chlorides are not hydrolyzed at all, being the salts of strong acids and strong bases, they assert that the nitrates are hydrolyzed, though to a less extent than the carbonates, being the salts of a stronger acid than carbonic. The natural inference is that the authors regard nitric acid as being a weaker acid than either hydrochloric or sulphuric.

It has long been recognized that the strength of acids depends upon their degree of ionization. In the third English edition of Treadwell's "Analytical Chemistry," Vol I., p. 16, we find that in $N/10$ solution, nitric and hydrochloric acids are both ionized in the extent of approximately 90 per cent., while in the third English edition of Ostwald's "Principles of Inorganic Chemistry," p. 248, we find the extent of the ionization of hydrochloric acid in $N/10$ solution to be 95 per cent., while that of sulphuric acid is only 57 per cent. It is thus evident that the view, commonly accepted by chemists, that hydrochloric and nitric acids are of approximately equal strength, and that sulphuric acid is considerably less strong, is correct. Since the only salts of the alkalis which are hydrolyzed are their salts with weak acids, it is clear that the sulphates, being salts of a weaker acid than nitric, should be hydrolyzed to a greater extent than the nitrates.

On page 247, Table 8, of their article, Stewart and Peterson show that while a 1-per-cent. solution of sodium nitrate dissolved 0.8 per cent. of the organic matter of a given soil, a 1-per-cent. solution of sodium sulphate extracted 1.19 per cent. of it, that is to say, 48.75

per cent. more than the nitrate. We have shown that sodium sulphate should be hydrolyzed to a greater extent than sodium nitrate; consequently, it should have not only a greater solvent action than the nitrate, but also a greater decomposing action on the organic matter, resulting in the production of a darker brown color. In view of the very general and abundant distribution of alkali sulphates in western soils, and granting the presence of sufficient organic matter for the production of a brown color according to the hypothesis of Stewart and Peterson, we should expect to find a uniform distribution of a dark brown surface color throughout the soils of the arid west. This is not the case.

As a matter of fact, neither the nitrates nor the sulphates are hydrolyzed at all. Stewart and Peterson admit that the sulphates are not hydrolyzed, but claim that the nitrates are. It is indeed difficult to reconcile their claim with the facts in the case. Since the alkali nitrates are not hydrolyzed, and since alkali hydroxides could be produced from them in no other way than by their hydrolysis, it is very evident that no alkali hydroxides are formed, and consequently the explanation of the brown color of the "niter spots" as given by Stewart and Peterson is nothing short of preposterous.

The question raised by the above writers concerning the relation of the pigment of *Azotobacter chroococcum* and the nitrate to the brown color of the "niter spots" applies only to the colorless strains of the organism. These have been shown by us to be capable of producing abundant brown to black pigment when supplied with very small quantities of nitrate (0.01 to 0.03 per cent. sodium nitrate) and some source of energy, both of which are present in our niter soils. Aside from these colorless strains, their contention is wholly irrelevant for we have already pointed out[1] that four of the seven strains of *A. chroococcum,* isolated from niter soils have produced, at one time or another, pigments varying in color from a delicate cream, through the different shades of brown, to an intensive brownish black in the *total absence of nitrates,* thereby attesting their ability to produce the pigment independent of the nitrate.

Walter G. Sackett,
R. M. Isham
Colorado Experiment Station,
Ft. Collins, Colorado

[1] Colorado Experiment Station Bulletin, 179, p. 33, June, 1911.

CALCULATION OF THE GAMMA FUNCTION

To the Editor of Science: In Science, April 2, 1915, Dr. Raymond Pearl has described a method of obtaining an approximate value of log $\Gamma(n)$ by interpolating in a table of log-factorial n.

In a table he compares the values obtained by interpolation, by Forsyth's method of approximation, and those found by using the relation

$$\Gamma(n+1) = n(n-1)(n-2)\cdots(n-r)\Gamma(n-r)$$

in conjunction with Legendre's tables, calling the value obtained by the last method the "exact" value.

Dr. Pearl explains that this "exact" value derived its name from the exactness of the mathematical argument upon which it is based, and not from any special accuracy in the numerical values given under that heading and he disclaims any greater degree of accuracy than can be expected from the summation of a large number of seven-place logarithms.

As the subject to be investigated is not how closely the values obtained by different methods agree with one another but how closely the approximate to the true value of the function, I have calculated a "more exact" value for the cases given by Dr. Pearl, using Legendre's table and ten-place logarithms and I believe the values so obtained are correct within a half-unit of the seventh decimal place.

Another set of values has also been calculated by means of Pearson's approximation formula[1]

$$\log \frac{\Gamma(x+1)}{x^x e^{-x}} = .3990899 + \tfrac{1}{2}\log x + .080929 \sin \frac{25^\circ.628}{x}$$

or

[1] "On a Formula for Determining $\Gamma(x+1)$," *Biometrika*, Vol. VI., p. 118.

$$\log \Gamma(x+1) = .6162372 + (x+\tfrac{1}{2})(\log x - \log e) + .080929 \sin \frac{25°.623}{x},$$

using seven-place logarithms except for the second or product term where ten-place logarithms were used to avoid introducing inaccuracies when x is large. This formula is also given in the introduction to "Tables for Statisticians and Biometricians" (Chicago University Press), on page lv, where unfortunately by a printer's error the value 0.3990899 is wrongly given as .03990899.

The various series of values are summarized in the following table.

VALUES OF LOG $\Gamma(n)$ BY DIFFERENT METHODS

n	Pearl's "Exact" Value	Pearl Forsyth	Pearl Using Δ^2	Pearl Using Δ^3	Pearson	"More Exact" Value
5.123	1.4613860	1.4613679	1.4619138	1.4615009	1.4613859	1.4613860
15.123	11.0834931	11.0834916	11.0835559	11.0834985	11.0834931	11 0834930
25.123	23.9637108	23.9637096	23.9637336	23.9637119	23.9637107	23.9637107
35.123	38.6594135	38.6594126	38.6594251	38.6594138	38.6594133	38.6594133
75.123	107.7498704	107.7498692	107.7498727	107.7498702[2]	107.7498702	107.7498702

The table shows that Dr. Pearl's "exact" value differs from the "more exact" value by two units in the seventh place for the larger values of n and in the case of $n = 75.123$ is inferior to the value found from interpolation when third differences are used.

A comparison of the values in the table leads to the following conclusions.

(i) For small values of n, up to about 5, it is preferable to use the exact method if Legendre's tables are available; in the absence of Legendre's tables the Pearson approximation formula should be used.

(ii) For larger values of n, as shown by the middle portion of the table, Pearson's formula is superior to the interpolation method and gives results which coincide with those found by the

(iii) For still larger values of n, 75 and upwards, the Pearson approximation formula and the interpolation method using third differences both give the true value to the seventh decimal place, but while the usefulness of the interpolation method is limited by the range of the existing tables of log-factorial n, that of the approximation method is not affected, provided a sufficient number of places be used in the logarithms of x and e when computing the second or product term.

P. F. Everitt

[2] Given as 107.7492870 in Dr. Pearl's article, being a misprint for the value given above, which I verified by recalculation.

THE POSITION OF REFERENCES IN JOURNAL ARTICLES

From one half to one per cent. of the space in the majority of scientific journals giving many references is wasted by the faulty position and arrangement of the references.

The amount of time wasted by the reader will depend on whether he is obliged to look up the references, or simply glances at them occasionally to see a date, or the name of an author or journal.

The word reference is defined here to mean the author's name, journal title (usually abbreviated), with the numbers for series, volume, pages and date. If any information from the original is also given, and printed at the bottom of a page outside the text, the whole is regarded as a foot-note, and is not considered here. *"Loc. cit.,"* is regarded as a reference.

Most journals are printed with a solid page, at the foot of which are the references for that page, with the reference numbers indicated in the text, a separate line being given to each reference, except where extra space is required either because of grouping several references under one number, or because of unusual length of names.

Nearly one per cent. of the space used in printing articles and references in this way can be saved by giving each reference a number (the numbers to run consecutively), then printing all the references at the end of the article, leaving an extra-wide spacing between the period at the end of one reference and the next number, in order to catch the eye. There

is nothing new in this method, for it has been used at rare intervals for a number of years.

The following illustrations taken at random from a number of measurements, show the state of the case as regards chemical journals, but the proposition is equally true for the journals of other sciences. The measurements have been made on the supposition that the same sized type will be used in both ways of printing the references. A space of five millimeters is allowed between the period at the end of one reference and the beginning of the number of the next, and extra space is allowed for in the case of articles containing over ten references, for these will require the use of numbers with two figures. Thus, an article with sixty separate references printed in the customary way will have, as a rule, from two to eight references on the page, and rarely require the use of reference numbers with two figures, while the shorter way requires the use of numbers up to sixty both in the text and at the end of the article.

A consideration of those illustrations in which the number of pages with no references is given, will make two facts obvious; that the estimate of the amount of space saved is only a rough approximation; and that it might easily be possible by deliberate selection of one hundred pages to get results widely different from those given here.

In the leading English journal, the *Journal of the Chemical Society,* all the references are printed in the text, so that there is no saving of space. In the *Journal of the Society of Chemical Industry,* Volume 32, 457–995 (1913), containing 100 pages of text of articles, about one eighth of a page could be saved. This journal has two columns to the page. Several of the articles have all the references at the end of the article.

In the *Bulletin de la société chimique de France,* Volume 13, 320–457 (1913), containing 100 pages of text of articles, over one half a page could be saved. There are 62 pages with no references. Some of the articles have the references printed two to the line, with extra space between the two.

In the *Berichte der deutschen chemischen Gesellschaft,* Volume 45, 403–503 (1912), about one half a page could be saved. The references in this journal at present are greatly abbreviated, thus, B. stands for the title of *Berichte,* etc. If space allows, instead of printing the references one to a line, they are always printed two to a line, with a space of 5 to 15 millimeters between the two. This method (a step in the right direction) naturally limits the saving possible. There are 61 pages with no references.

In the *Gazzetta chimica italiana,* Volume 42, I., 316–416 (1912), nearly three quarters of a page could be saved. There are 61 pages with no references.

In the *Journal of the American Chemical Society,* Volume 34, 1631–1731 (1912), one page can be saved. There are 54 pages with no references. In the *Physical Review* an article always begins at the top of a page. The effect of this is that there is sufficient space at the end of most articles to print all the references, often on the basis of a line for each reference.

In the case of journals printed with two columns to a page, there is an incredible numbers of variations in the way in which numbers indicating references are used, as, for instance, giving numbers consecutively for the references in one article regardless of the number of columns used for the articles, or using numbers consecutively for one column regardless of the number of articles in that column, etc. These variations doubtless relieve the monotony of the work of editors, printers and proof-readers.

There is one great advantage in the method recommended here. It does away with "*loc. cit.,*" the abbreviation so easy to write, so saving of time and space in printing, so wasteful of time to one who has to go back an indefinite number of pages and read an indefinite number of references, in order to find where the authority for a given statement may be found. When many articles by one author, or many patents by one man are given, this "*loc. cit.*" may be so indefinite that it will be necessary to look through a number of the originals in order to get at the one desired. In a series of

articles, "*loc. cit.*" may refer to a reference published in a preceding article, sometimes to one in a preceding volume. In one case approaching the limit of misuse, the statement in the text reads, "Harvard[2] and Princeton[8] laboratories." The reference number 2 is to "*loc. cit.*" On looking at reference number 1 it is found that the word "Harvard" is not mentioned at all. In order to make sure that this "*loc. cit.*" did not refer to a reference in some preceding article, both the publications under number 1 would have to be noted and examined by any one unfamiliar with the fact that a man with a certain name, interested in a certain subject, was writing articles coming from Harvard in a particular year. This contingency will arise in some future time.

There are two classes of readers interested in the position of references. The reader who wishes only to see the date of a statement referred to in the text, or the name of the journal in which the statement was published, naturally finds it easier to look down at the foot of the page, instead of turning to the end. But the reader who wishes to look up an original article is willing to take this small trouble of turning to the end, especially when it saves time in the long run. Having had to read through articles, and look over references which ran in number into the hundreds of thousands, then look up thousands of the original articles from these references, I can speak from adequate experience of the positive value of the method recommended here, for it was always a pleasure and relief to come across the few articles using it.

Since there is a constant plea for saving of space in articles presented to scientific journals, a method of economy which will save from one half to one per cent. of the space now used, and at the same time increase the ease of looking up references and authorities, seems worthy of consideration.

HEYWARD SCUDDER

SCIENTIFIC BOOKS

Essays and Addresses. By the late JAMES CAMPBELL BROWN, D.Sc. (Lond.), LL.D. (Abdn.), Professor of Chemistry in the University of Liverpool. With a Portrait and Twenty-two Illustrations. London, J. & A. Churchill. 1914. Pp. x + 208. Price $2.00 net.

A memorial volume is always of interest to the former students of a loved professor and to such this collection of essays and addresses by the late Dr. Campbell Brown will chiefly appeal; but from another standpoint this book is of interest not merely to chemists, but to all who come into touch with chemical industry, in that it presents the opinions of a discerning critic, expressed from time to time in a more or less popular way to audiences interested in the development and utilization of chemistry. This is particularly true at the present time when so many are turning their attention to the applications of chemistry to conditions of war.

Of the twelve addresses, three were delivered as chairman of the Liverpool Section of the Society of Chemical Industry, five before the Students' Chemical Society of University College, Liverpool, and two before joint meetings of the societies of the same college. The period covered in these addresses is 1886 to 1908, and many of the thoughts are equally applicable to the present time, especially those dealing with education.

It is interesting to read in the address on Technical Education delivered in 1886, Dr. Brown's strong plea for linking a sound early mental training with education of the hands, an idea which has been developed in this country along the line of the manual-training schools. Dr. Brown would, however, solve the problem along somewhat different lines. He would have workshops for different kinds of trades erected in a few well-chosen districts of a town, and require each scholar to spend a sixth day of every week in one or other of these shops, such day being counted as a part of regular school attendance. A single workshop would thus serve for a considerable number of graded schools, and the workshop day would be looked forward to as almost a holiday. He says: "By this system I do not think that the amount of ordinary school work would be lessened; but if it were, the decrease would

be very slight, and the reply to objections is, that some provision for training the hands and muscles to work is essential to an embryo workman, is beneficial to an embryo gentleman, and must be had at any sacrifice if we, as a nation, are to maintain our position in the face of other competing nations." This idea is in a few instances carried out in this country as regards higher technical education and with apparently good results, and would probably be better in our high schools than the present diversion of a part of our boys to manual training schools. But the greatest advantage would seem to be with the children in the grades.

Again Dr. Brown takes issue with the prevalent craze for a *practical* education in the sciences. "In the teaching of science it is a great mistake to aim *specially* at imparting a knowledge of facts which will be of use in after life. It is the desire to do this which has gone a great way in encouraging the multiplication of science subjects in schools. It would be far better to teach one science subject substantially and well than to teach a smattering of several. Every boy and girl, in whatever sphere of life, should be taught one science as a part of ordinary school training, but the mistake is too frequently made, both in science teaching and in ordinary school routine, of forgetting that it is the mental training and discipline, and not the storage of facts, that form the valuable feature of school work—the training of the understanding and the development of the reasoning faculties rather than the exercise of mnemonics." He considers that natural history, either vegetable or animal, is best adapted to the purpose of training the powers of observation and classification.

Again emphasizing the same idea in another address: "The use or object of education is not to impart a number of facts useful or otherwise, nor even to give useful hints and receipts that will enable the scholar to pursue some particular occupation; not to enable him to earn a living, or to earn a better living. That will follow, of course, as a secondary result of education, but its direct objects are of a far higher character. (1) To train the mind and its various powers, memory, reason, habit of precise observation, and arranging things which resemble each other and distinguishing things which differ. (2) Not so much to impart knowledge as to awaken the faculties and give the power of acquiring unlimited knowledge for oneself. (3) To cultivate the sense of the beautiful, not only of artistic beauty, which is of a material and physical kind, but a sense of intellectual order and beauty also. (4) And in all these ways to increase the happiness and the capacity for happiness of human beings." And then he adds: "If, in the course of education, some store of facts can be acquired at the same time, so far so good—for life is short—but that is not the first object of education."

To the young employees in the various works and mines of England he would send this message: "It is not merely by attending faithfully to their routine duties and performing them to the satisfaction of their employers that the Germans are beating them as clerks, beating them as inventors, beating them as workmen, beating them as manufacturers, beating them steadily in the markets of the world—for it is true that the Germans are doing all this—but because every German boy and girl, for more than two generations, has received a broad and thorough education, at institutions where every one is compelled, not merely to do routine lessons, but to think and train his intelligence; to learn principles and apply these principles in many practical ways; and unless the young Englishman engaged in industrial or commercial pursuits will set to work earnestly to broaden and deepen his education by systematic study after he has left the ordinary school, it is certain that the German, who is rapidly replacing the Englishman in some of the markets of the world, will replace the Englishman at home also. I do not doubt that the Englishman can, by his energy, beat the German as he has done in the past, but at present he is not doing so, and he is not even training himself in the right way for the struggle of life." "During my last visit to some of the industrial parts of Germany, I was very much struck, as every one would be, by the immense advance which was apparent as compared with a previous visit. Not only the employers, but the em-

ployed, are men of education. The managers and heads of departments, often those who are analogous to what we should call foremen in England, have a university education. All have spent many more years on their education than is usual in England."

In an address on "The Ethics of Chemical Manufacture," Dr. Brown would have the manufacturer remember that he has other and higher privileges, and that nobler duties devolve upon him than those which necessarily occupy the greater part of his thoughts during business hours. The satisfactory thing to contemplate in the development of the alkali industry is not the fortunes it made, nor even the employment it gave to thousands, but that it gave cheap and abundant means of cleansing self, raiment and dwelling to every family among the civilized nations of the earth. Balard is revered now not because he manufactured so many thousand kilos per week of salt from the sea water, but because, experimenting one day with the mother liquor, he observed for the first time some reddish-brown vapors, and followed them up, and became the discoverer of bromin. "Joule doubtless made excellent beer, because he is the sort of man who does everything well he undertakes; but his great work for which the world is indebted to him, and by which he will be remembered with gratitude throughout all time, was his determination of the mechanical equivalent of heat, whereby he laid the foundation of chemical dynamics and of the science of thermal chemistry, as well as brought about a revolution in an important branch of physics." The coal-tar dyestuff industry is not looked upon with much favor by Dr. Brown. "When one sees the glaring colors which are now flaunted before the public eye, often without any thought of harmony and with no consideration of appropriateness of position and surroundings —in advertising placards, house decoration, dress and so forth—one is sometimes tempted to ask whether the production of these new dyes has been a good thing for mankind, and whether, when our last mines are worked out and coal-tar dyes cease to be manufactured, the world will be any better for having had them, and whether the huge industry, which is at present flourishing, is not a waste of time, and of carbon compounds that would be better saved to keep us warm in winter—whether, at least, its highest merit is not that it affords a present means of livelihood to so many thousand workmen." The knowledge gained from the study of coal-tar products is the real justification of the "waste"; "this, rather than cheap alizarin, gaudy bills, brilliant shop windows and rainbow-colored dress, is the thing of which the coal-tar manufacturer should be proud."

A most interesting chapter is the address, "Reminiscences of August Wilhelm von Hofmann." Dr. Brown was a student in Hofmann's laboratory in the school of mines, and the story of the great master in lecture room and laboratory is most entertainingly told, with delightful personal touches. Here also we find most favorable views of German industry as he speaks of Hofmann's students and assistants working from nine in the morning till six at night, and often returning after dinner to work privately till a late hour. "That is the kind of work which tells. An eight-hours day may be all very well for working men who have no ambition and who are content with daily bread (and beer); but a gentleman has to work much harder."

There is included in the volume Dr. Brown's translation of the autobiographical fragment of Liebig, which originally appeared in the *Deutsche Rundschau* for January, 1891, and which is of great interest; and also a single original investigation, "Aquiculture: a Study of Deposits in Pipes and Other Channels Conveying Potable Water," read before the Institution of Civil Engineers. Altogether, the book as a whole is well worth perusal, both by chemists and by the general public.

J. L. H.

SCIENTIFIC JOURNALS AND ARTICLES

THE July number (Vol. 16, No. 3) of the *Transactions of the American Mathematical Society* contains the following papers:

M. Fréchet: "Sur les fonctionnelles bilinéaires."

D. F. Barrow: "Oriented circles in space."

D. Buchanan: "A new isosceles triangle solution of the three-body problem."

L. P. Eisenhart: "Surfaces Ω and their transformations."

E. J. Wilczynski: "The general theory of congruences."

J. H. M. Wedderburn: "On matrices whose coefficients are functions of a single variable."

E. Kasner: "Conformal classification of analytic arcs or elements: Poincaré's local problem of conformal geometry."

D. R. Curtiss: "Extensions of Descartes' rule of signs connected with a problem suggested by Laguerre."

J. B. Shaw: "On parastrophic algebras."

The concluding (July) number of Vol. 21 of the *Bulletin of the American Mathematical Society* contains: Report of the April meeting of the society in New York, by F. N. Cole; "An elementary double inequality for the roots of an algebraic equation having greatest absolute value," by G. D. Birkhoff; "Certain non-enumerable sets of infinite permutations," by A. B. Frizell; "George William Hill, 1838–1914," by E. W. Brown; Review of Dickson's Linear Algebras, by W. C. Graustein; "Shorter Notices": Poincaré's Wissenschaft und Methode, by J. B. Shaw; Martin's Text-book of Mechanics, Vol. 5, by F. L. Griffin; "Notes"; "New Publications"; Twenty-fourth Annual List of Published Papers; Index of Volume 21.

SPECIAL ARTICLES

THE THEORY OF MAGNETIZATION BY ROTATION

The experiment which I described in a recent number of this journal may be considered as a modification of an experiment made long ago by Maxwell,[1] who appears to have been the first to conceive the idea that a magnet should behave like a gyrostat if its Ampèreian currents are actually *material*, as modern theory assumes. In Maxwell's experiment an electromagnet, mounted in a frame in such a way as to be free to move about a horizontal line through its center of mass and perpendicular to its magnetic axis, was rotated at high speed about a vertical line, and optical observations were made to see whether the angle α between the vertical and the magnetic axis was altered as the speed increased from zero, stability being secured by properly adjusting the moments of inertia. No change in α was observed, but only rough experiments were possible.

[1] *Elec. and Mag.*, § 575.

In my experiment the electromagnet is replaced by each of the countless multitude of molecular magnets of which the iron rod is constituted, and the total change in the orientation of all the magnets with reference to the axis of rotation of the rod is determined magnetically instead of optically.

In the complete paper it is shown that the angular momentum M of the simplest type of molecular magnet possible, constituted of a negative electron with mass m and charge e revolving with angular velocity ω in a circular orbit about a positive nucleus with charge $-e$ at rest, is related to the magnetic moment μ by the equation

$$M = 2(m/e)\mu. \qquad (1)$$

If now the rod of which the molecular magnet is a part is set into rotation about its axis AB, with angular velocity Ω, the angle α between the vector M and AB will *decrease*, just as in the case of a gyroscope, until the torque T' on the system brought into existence by this displacement is just equal to the rate of increase of its total angular momentum in the steady state when kinetic equilibrium has been reached and the vector M is tracing out a conical surface with constant semi-angle α and angular velocity Ω. The effect in this steady state is exactly the same as if the rod were at rest and the molecular magnet were acted upon by a torque $T'' = -T'$ due to an extraneous magnetic field of strength H, where H is the intrinsic magnetic intensity of rotation. The complete expression for the torque T'' is known (and can readily be shown from first principles) to be

$$T'' = -T' = -M\Omega \sin \alpha - B\Omega^2 \sin \alpha \cos \alpha, \qquad (2)$$

where B denotes the difference between the

two principal moments of inertia of the orbital system. In the case under consideration $B = M/2\omega$. Eliminating B and M from (2) we get

$$T' = -\mu \sin\alpha \cdot 2\frac{m}{e}\left(1 + \frac{1}{2}\frac{\Omega}{\omega}\cos\alpha\right).^{2} \quad (3)$$

If we divide this expression by $-\mu \sin\alpha$ we shall, as in the case of an ordinary magnetic field, get the intensity sought, viz.,

$$H = 2\frac{m}{e}\Omega\left(1 + \frac{1}{2}\frac{\Omega}{\omega}\cos\alpha\right).^{3} \quad (4)$$

The magnitudes of Ω experimentally attainable are so small in comparison with ω that the second term is always negligible.

If we assume that e/m has the value (-1.77×10^7) ordinarily accepted for the negative electron in slow motion, and put $\Omega = 2\pi n$ where n is the speed of the rod in revolutions per second, we get for the intensity per unit speed

$$H/n = -7.1 \times 10^{-7} \frac{\text{gauss}}{\text{r.p.s}}. \quad (5)$$

This is the *maximum* magnitude possible; if some or all of the positive ions also have orbital motion, H will be smaller in magnitude than indicated by (4), but will still be proportional to Ω. The experimental value of H/n was, within the accidental error, one half that given by (5).

S. J. BARNETT

THE OHIO STATE UNIVERSITY

[2] This equation also follows immediately from Maxwell's equation by putting in the conditions here assumed.

[3] The first term of this equation has been given previously, by Einstein and de Haas, but was obtained incorrectly, equations for a *molar* magnet instead of a *molecular* magnet being employed.

THE TRANSMISSION OF POTATO MOSAIC THROUGH THE TUBER

MOSAIC of the potato is very prevalent in Bermuda on the Bliss Triumph and is the cause of serious losses to the growers, as the yield of affected plants is reduced from 10 to 75 per cent., and often a field will have a large proportion of plants with this disease.

An inspection made in July, 1914, of the fields on Long Island in which stock was being grown for shipment to Bermuda for seed purposes showed the almost general presence of mosaic on the Bliss Triumph. The same condition existed in many fields of Bliss Triumph in Maine, where the stock for Long Island is obtained. These general facts strongly indicated that the mosaic of potatoes was transmitted by the tubers, in the first case from Maine to Long Island and in the second generation from Long Island to Bermuda.

There was, however, no evidence in the literature on potato growing to support this view. Dr. W. A. Orton, in Bulletin 64 of the United States Department of Agriculture, on "Potato Wilt Leaf Roll and Allied Diseases," writes, "it is not improbable that mosaic is transmitted by the tubers" adding, however, that no experiments had been undertaken that had conclusively proved this. Experiments were consequently conducted at the agricultural station in Bermuda with a view to securing definite information on this point.

Through the courtesy of Drs. I. E. Melhus and L. O. Kunkel, of the Bureau of Plant Industry of Washington, tubers from selected hills of healthy and mosaic parents were obtained from a field at Van Buren, Maine, that was visited by the writer in September, 1914.

The tubers obtained from Van Buren were planted in Bermuda in November, 1914, in duplicate rows, and the result showed in a striking manner in January, 1915, that the mosaic of potatoes is transmitted through the planting of tubers from mosaic parents:

No. of Plants	Tubes Selected from	Percentage of Mosaic Plants
A. 200	Healthy parents	nil (4 or 5 doubtful)
B. 200	Stock on the market	80
C. 200	Mosaic parents	100

The yield from the plants affected with mosaic was less than half that of the healthy stock.

Mosaic of the potato is undoubtedly one of the serious potato problems that have escaped the notice of the practical farmer and that have until recently received little attention from scientific workers. To growers of the

Bliss Triumph in particular it is a matter of considerable importance, and the result of these experiments shows that the disease can be readily controlled by field selection of the stock intended for planting next season.

It is believed that the experiments reported here are the first that have definitely shown that potato mosaic is transmitted through the tubers. A series of photographs have been taken which show the difference between the progeny of healthy and mosaic parents and it is intended to publish a fuller account of the experiments at an early date.

E. J. Wortley
Paget East, Bermuda

THE INHERITANCE OF EXTRA CONTRACTILE VACUOLES IN AN UNUSUAL RACE OF PARAMŒCIUM CAUDATUM

In the early part of January, while examining paramœcia from a general culture maintained for laboratory purposes, it was noticed that one of the individuals had three contractile vacuoles. Further investigation showed this condition to be the rule rather than the exception, and a number of single individuals, each showing three vacuoles, were isolated with which to start pure-line cultures.

The descendants of these single individuals showed wide variation in vacuole number. In one pure line several weeks after it started 8.6 per cent. of the individuals had two vacuoles, 65.7 per cent. had three and 25.7 per cent. had four. In other cultures numbers as high as five and even six vacuoles appeared rarely. Immediately after division the average number is lower; in some very rapidly dividing cultures as many as 59.1 per cent. of the individuals may have only two vacuoles, though this return to the normal number apparently is only temporary, as the same individuals may later develop a third or even a fourth vacuole. This condition is represented by the following experiment in which an individual showing two vacuoles was allowed to pass through several divisions and then three observations were taken on each of the descendants at intervals of from four to five hours.

2

2	2	2	2	2	3	2	4	2
3	3	2	2	4	3	2	4	2
4	3	2	2	4	3	2	4	3

It is evident that all the individuals starting with two vacuoles did not later acquire a third, nor did all those having three to begin with have four before division. Those paramœcia possessing but two vacuoles, although they may divide without having shown an increase in the number of vacuoles, have not lost the power of producing extra contractile organs though several generations may be passed through before they appear.

In this multi-contractile vacuoled race the extra vacuoles are with very few exceptions located in the posterior half of the *Paramœcium*. In cases where three are present, two are found in the posterior half and one in the anterior. Only two cases have been observed in which the reverse condition was true. When four vacuoles exist the arrangement is generally three in the posterior and one in the anterior end, although there may be two in each end.

No exact observations have been made as yet on the formation of the new vacuoles. Very small vacuoles have been seen which have apparently just formed and which are usually at some distance from the others. These increase fairly rapidly in size until they reach the maximum. During the growth of some new vacuole, the one nearest to it loses temporarily its regular contraction. When the new vacuole has reached full size it beats spasmodically a few times before it settles down to its regular rhythm. Shortly the old and the new vacuoles become accustomed to the new conditions and the usual rhythmic beat begins. This is not always the case, as vacuoles have been observed to form without affecting the rhythmic beat of the older vacuoles near it in the slightest.

It is practically impossible at present to predict with certainty what number of contractile

vacuoles the offspring of any individual may have immediately following division. Some of the possibilities observed up to date are illustrated below.

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
2	3	3	3	3	4	4	5
2 2	2 2	3 2	3 3	4 2	4 2	3 3	4 2

Apparently at division two vacuoles are added in the normal way as a rule (one to the posterior end and one to the anterior). This is not invariable as is evidenced by (*b*), (*d*) and (*h*). As stated above, although a *Paramœcium* of this race may not show an increase of vacuole number up to the time of division it has not lost the power to produce extra vacuoles. In cultures started with two-vacuoled forms, individuals have been found showing three and four vacuoles. The most common distribution at division in the three-vacuoled individuals is three vacuoles to the posterior part and two to the anterior half. There is no fixed order in the distribution of the vacuoles at division and no definite time at which the extra contractile vacuoles appear in the life cycle of the individual. The only definite statement that may be made of this race is that it has a tendency to more than two contractile vacuoles.

The race is strong and healthy and some of the individuals are very large. There is no invariable relation between the size of the animal and the number of vacuoles. A small animal may have more than a larger one. Since the race has been under observation (about four months) there have been two periods of extremely rapid division, the rate rising to five divisions in twenty-four hours and continuing at this rate for six or seven days. During these periods no individuals with four or five vacuoles were seen and the two-vacuoled forms seldom passed into the three-vacuoled condition before division, although they did not lose the power of returning to the higher numbered vacuoled state when the division rate slowed down.

The original laboratory culture was started by Dr. Merkle Jacobs in the fall of 1914. The paramœcia he had been using in high temperature experiments were thrown into a battery jar of hay infusion. So far as is known, the animals used for these experiments had the normal number of contractile vacuoles, though there is a possibility that the higher number were already present. The irregularity of the behavior of the extra contractile vacuoles would seem to indicate that they were recently acquired structures that had not become as yet firmly established as a part of the organism. There has also been some slight indication lately, observed by both Dr. Jacobs and myself, of a tendency to settle down into a more regular order with three as the maximum number of vacuoles.

Since *Paramœcium caudatum* has been the most widely studied protozoan and no cases have been reported where extra contractile vacuoles have been found, considering the origin of the culture, there is some excuse for suggesting that this potentiality for extra vacuoles may have been acquired. The great irregularity of the time of formation of these vacuoles along with the tendency to become more regular, as stated above, would seem to bear this hypothesis out. The paramœcia of the original culture had been subjected to a temperature of at least 40° Centigrade and it might be supposed that the extra vacuoles were formed under the stress of the unusual environment. Furthermore, Dr. Jacobs has found that this race is abnormally resistant to high temperatures. Under the conditions where ordinary race of paramœcia are killed at temperatures of 40° Centigrade to 42° the race in question will survive an exposure to 44° or more.

A more extended account will be published shortly giving more of the details and methods. It is intended later to attempt to develop a new multi-vacuoled race by subjecting normal individuals to high temperatures in order to test the hypothesis suggested above.

Dr. Jacobs has carried on experiments with the same race of *Paramœcium* which have confirmed those recorded here.

Robert T. Hance
Zoological Laboratory,
University of Pennsylvania

OBSERVATIONS ON AZOTOBACTER

THE group of bacteria having the capacity of using free atmospheric nitrogen in their metabolic processes consists of three general types: (1) Those associated with the nodule formation of legumes (*Ps. radicicola*); (2) large bacilli which produce spores located in the center of the cell, causing an increased diameter of the cell at that point (*Clostridium pasteraneum*); and (3) a form displaying considerable variation in size and shape, which, according to original descriptions, is without endospores (*Azotobacter* sp.).

The discovery of the extraordinary ability of these organisms to secure a supply of nitrogen from the air brought them into immediate prominence as objects of systematic study. The nitrogen-assimilating property was first detected in the *radicicola*, and hence the earlier studies were concentrated upon this organism. After the isolation of the other two forms, however, they assumed quite as much importance as had attached to the legume organism. In fact, recently more attention has been given to the former than to the latter. This has been especially true of the *Azotobacter*. The *Clostridium* has never been so inviting as either of the others; perhaps because of its morphological uniformity. Then, too, it appears to have less nitrogen-gathering power.

At various times, while working with other phases of the problem of soil bacteriology, I have attempted to isolate the *Azotobacter* from our local soils and study it rather intensively. On several occasions these efforts have resulted in the securing of pure cultures of the bacillus. So far as the observations went, however, no peculiarities were presented which had not previously been noted by other investigators. During the year 1913 a culture was secured which showed some striking qualities. These attracted immediate attention and led to an extensive study.

Soon after the isolation of *Azotobacter croococcum* by Beyerinck, other investigators gave descriptions of five or six types of *Azotobacter* which they regarded as distinct species. One of these forms was given the name *Azotobacter vinelandii* by Dr. J. G. Lipman, who isolated and described it. The chief basis upon which this species was established is the quality of pigment production. In this case the color of the pigment is a distinct yellow, as contrasted with the heavy brown pigment of *A. croococcum*.

From the outset the bacillus under consideration here has been regarded as a variety of *A. vinelandii*. In many respects, however, our type differs so markedly from the original description of *A. vinelandii* as to create considerable doubt as to the identity of the species. Nevertheless, I am still disposed to regard it as a mere variety within this group. As a matter of fact, the recent work of Prazmowski and others tends to eliminate the various species of this organism and regard them all as one species consisting of several varieties. My own observations lead me to favor this contention. The pigment color of the culture in my laboratory shows considerable variation, ranging from yellow to brown. This seems to depend largely upon the medium used.

The following comparison will show the chief points in which our type varies from the species description:

Features Considered	Original Description	Observation Made in the Present Investigation
Mannite agar plates	Colonies 4 mm. in 4 days.	Colonies 6–8 mm. in 4 days.
Mannite agar plates	Colonies whitish.	Colonies yellow.
Glucose solution	Surface film.	No surface film.
Mannite solution	Yellow pigment.	No pigment.
Glucose agar stab	White.	Yellow.
Mannite agar stab	White.	Yellow.
Potato	Dirty white.	Pink, young; yellow, old.
Spore formation	Absent.	Present.
Thermal death point	80°–85° C., 5 min.	90°–95° C., 5 min.

Probably nothing else in this comparison is so significant as the disagreement in regard to the spore production and the corresponding high thermal death point of our cultures.

Beyerinck, in his original observations on *Azotobacter croococcum,* failed to detect the presence of spores. Nevertheless, in 1911 E. Mencl[1] demonstrated their presence in this species. It was recognized early in the study of *Azotobacter* that they are very resistant to drying and other adverse conditions, which fact aroused the suspicion that spores are produced. The morphological irregularity and change of form under different cultural conditions obscured the true nature of the case until the date mentioned above. If all *Azotobacter* are to be regarded as one species, my observation of spores is, of course, only a repetition of observations made recently by several investigators.

In the cultures with which I worked the organisms attained very great size, and showed in many cases a striking resemblance to budding, similar to that observed in yeast cells. At such times the cell is well filled with refractive bodies which do not stain readily with the analine dyes. Such bodies have generally been looked upon as fat, but the fact that by special effort they can be stained with methylene blue led to some doubt as to their fatty nature. Efforts were made to stain these bodies with the ordinary fat stains, such as Soudan 3 and Sharlac red, but the results were all negative. *Azotobacter* were then grown on potato in sufficient quantities to secure a sample large enough for ether extraction. Potatoes were cut in thin slices and sterilized in petri dishes, and then inoculated. The growth was excellent, and a considerable mass of this was secured by scraping from the surface.

The material thus secured was placed in a separatory funnel and treated with pure ether for twenty-four hours without heat. The funnel was shaken several times during the extraction and then allowed to stand for sedimentation. Several cubic centimeters of the clear solution were then drawn into a weighed platinum dish and evaporated to dryness. It was found that a sediment detectible by weight was left in the dish. This may have been a mixture of fats, gums and resins, or possibly any one of these.

The funnel in which the extraction was made was set aside with the residue of the bacterial mass and a thin layer of ether which overlay the mass. No attention was given to it for about two weeks. When it was examined there was a brownish layer on the surface of the ether. This layer gave one the impression that it consisted of a bacterial growth. Ether has, of course, been regarded as a disinfectant, and although it has never been thought of as having great germicidal power, yet in a high concentration one would certainly be surprised if it should not be found sufficient to inhibit all growth.

Cover-glass preparations were made from the scum on the ether in the funnel referred to, and it was found to contain large numbers of bacteria. These might have come from the original mass from the potato and been dead at the time they were taken from the ether. At the same time that the microscopic preparations were made, however, inoculations on agar were placed in the thermostat for incubation. At the end of twenty-four hours, when the agar tubes were examined, they were found to have a good growth on them, stains from which showed that it consisted of *Azotobacter.* It was evident, therefore, that practically pure ether had not killed this organism. It was also made reasonably certain by this observation that the scum on the ether in the funnel consisted of living *Azotobacter.*

It remained to be shown that the organisms were actually multiplying in the solution. This was accomplished in the following way: Small Ehrlenmeyer flasks were supplied with sufficient Squibb's pure ether to make a thin layer on the bottom of the flask and a small particle of the potato culture was introduced into them. These were set aside at room temperature for development, and at the end of a week or ten days a decided growth could be detected.

Another method that was employed to test

[1] *Arch. Protistenk.,* 22 (1911), No. 1, pp. 1–18.

the ability of *Azotobacter* to grow in the presence of ether consisted in placing cylinders of potato in test tubes having plugs of absorbent cotton in the bottom saturated with pure ether. The slant of the potato was inoculated with the organism and incubated at room temperature. These cultures almost invariably had a growth at the end of from eight to ten days. The growth on potato had a decided stringiness. Stains from such a mass revealed a dense zooglea.

In the case of the cultures in liquid ether the only apparent source of carbon is the ether itself, and the bacteria are therefore under the necessity of using this in their metabolic processes. When the flasks containing old cultures were examined from day to day it was possible to detect what appeared to be the odor of alcohol and ether alternately. The successive hydration of ether and dehydration of alcohol would account for this phenomenon, but the probability of bacteria being able to induce these changes is certainly extremely remote. The oxidation of ether has recently been shown to result in the formation of aldehyde and acetic acid. Any attempt, however, to explain the nature of the process taking place in the flasks would be mere speculation, since the matter has not been experimentally investigated.

MAURICE MULVANIA

KNOXVILLE, TENN.

THE ROYAL SOCIETY OF CANADA

THE thirty-fourth annual meeting of the Royal Society of Canada was held in Ottawa, May 24 to May 27, inclusive, under the presidency of Sir Adolphe B. Routhier. The attendance was one of the largest in the history of the society, founded in 1882 by the Marquis of Lorne, at the time governor general of Canada. The four sections into which this national society is divided met under their respective presidents: Section I., French literature, history, archeology, etc. (in French); Section II., English literature, history, archeology, etc. In this section the following papers are of scientific value: "Some Notes upon the Discovery of a Prehistoric Human Skeleton in British Columbia," by Charles Hill-Tout. This skeleton came "from Undisturbed Strata in the white silts of the Interior Plateau" of that province, near Kamloops, and places the prehistoric history of man in western Canada back to the glacial period. "Social Organization of the West Coast Tribes," by Professor Adam Shortt, C.M.G., also forms an interesting study.

Section III., dealing with the mathematical, physical and chemical sciences, comprises numerous papers of special interest and value.

Professor R. F. Ruttan (McGill University), discussed "The Chemistry of Adipocere."

This paper deals with the changes in animal fats, as the result of prolonged action of moisture with the exclusion of air. The adipocere studied was found in a recent Post-Tertiary deposit of wet soil near Ormstown, Quebec. The material had the general character and appearance of soft chalk to the touch.

Another paper by Dr. Ruttan was entitled "Glycol Esters of the Fat Acids," pointing out a new series of fats formed by the replacement of ethylene glycol for the glycerol of ordinary fats.

Dr. Harding presented the result of investigations by him and Messrs. A. R. Maclean and F. H. S. Warneford, on "The Ninhydrin Reaction," being a critical study of this reaction for alpha amine acids, its quantitative relations and the chemistry of the color produced.

Then followed numerous contributions in the physical and mathematical sciences, and in astronomy, spectroscopy, electricity, metallurgy, meteorology, etc. These include:

A Comparison of Radium Standard Solutions: J. MORRAN. Presented by PROFESSOR A. S. EVE, F.R.S.C.

Notes on the Penetrating Radiation from the Earth: PROFESSOR A. S. EVE, F.R.S.C.

Some Experiments on the Thermionic Current: PROFESSOR A. S. EVE, F.R.S.C.

The Solar Rotation: DR. J. S. PLASKETT, F.R.S.C.

This paper gives the values of the spectroscopic determination of the Solar Rotation from plates made at Ottawa in the years 1911, 1912, 1913. A summary of the rotation values at different latitudes, the formula connecting the variation of velocity with latitude and discussions of other important aspects of the question was given.

The Determination of the Distance of the Nearer Stars from their Proper Motions and Radial Velocities: REYNOLD K. YOUNG, Ph.D. Presented by DR. J. S. PLASKETT, F.R.S.C.

From 167 stars whose parallax, radial velocity and proper motion are known, the direction and magnitude of the solar motion was found. The mean distance of the stars was evaluated by a comparison of the mean radial velocity and mean

proper motion at right angles to the direction of the sun's way, also by a comparison of the parallactic motion with the solar velocity. While the results of these two methods differ considerably their mean agrees with the observed parallax.

On the Electrical Conductivity of Air Confined in an Ice Vessel: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. HAROLD G. MURRAY.

On the Residual Ionization in Gases over the Sea and on the Surface of Lake Ontario: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. C. L. TRELEAVEN, B.A.

On the Absorption Spectra of Zinc and other Metallic Vapors: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. EVAN EDWARDS, B.Sc.

Note on the Ultra-Violet Spark Spectrum of Silicon: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. EVAN EDWARDS, B.Sc.

On the Ionization Potentials of Mercury Zinc and Cadmium Vapors and their Single Line Spectra: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. J. P. HENDERSON, B.A.

Application of Wilson's Method to a Study of the Ionization Paths of Alpha Rays in Hydrogen: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. H. N. MERCER, B.Sc.

On the Delta Radiation from Zinc freed from Gases under Bombardment by Alpha Rays: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. C. G. FOUND, B.A.

On the Infra-red Spectrum of the Mercury Arc: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. R. C. DEARLE, B.A.

On the Resolution of Spectral Lines by an Electric Field: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. K. H. KINGDON, B.A.

On the Study of Röntgen Ray Spectra: PROFESSOR J. C. MCLENNAN, F.R.S.C., and MR. A. R. MCLEOD, M.A., and MR. R. L. LEWIS, B.Sc.

The Crushing Strength of Ice: PROFESSOR H. T. BARNES, F.R.S.C., and MR. H. M. MACKAY.

Experiments on large blocks of ice were made on the Emery testing machine. The results agree with those presented last year.

The Effect of Strain on the Thermal Expansion of Quartz: PROFESSOR H. T. BARNES, F.R.S.C.

Quartz rods were put under tension up to their breaking point and the coefficient of expansion measured between 0° and 100° C. No effect was observed.

Secondary Cathode Rays from Gases: A. NORMAN SHAW, D.Sc. Presented by PROFESSOR H. T. BARNES, F.R.S.C.

On Osmosis in Soils: C. J. LYNDE, and V. V. DUPRÉ. Presented by PROFESSOR H. T. BARNES, F.R.S.C.

This paper gives the results of experiments made to determine whether or not the pressures observed are due to osmosis.

On the Flow of Air in Two-dimensional Channels with Special Reference to the Stability of Stream Line Motion: LOUIS VESSOT KING, M.A. (Cantab.).

An account is given of experiments carried out with the author's hot-wire anemometer on the distribution of velocity in the flow of air between parallel planes. The observations were taken with a view of obtaining some light on the conditions which determine the breakdown of stream-line motion into turbulent flow.

On the Distribution of Air Velocity in the Neighborhood of a Rotating Cylinder: A. GRAY, B.Sc., and LOUIS VESSOT KING, M.A. (Cantab.).

On the Calculation of the Self and Mutual Induction of Coaxial Cylindrical Coils: LOUIS VESSOT KING, M.A. (Cantab.).

I. A new method of deriving the formulæ for the self and mutual induction of coaxial cylindrical coils is obtained by reducing the problem to one of calculating a simple case of gravitational attraction.

II. By the application of Gauss's theorem of the Arithmetico-Geometrical mean, the calculation of the elliptic integrals which occur in the formulæ for self and mutual induction of coaxial single layer coils is made possible to a high degree of accuracy with comparatively little labor of computation and without the use of Legendre's tables.

III. Simple quadrature and graphical methods for the approximate calculation of the constants are also described.

Geometrical Configurations that lead to the Solution of a System of Partial Differential Equations of the Second Order: CHAS. T. SULLIVAN. Presented by DR. J. HARKNESS, F.R.S.C.

Progress on the 72-inch Reflecting Telescope: DR. J. S. PLASKETT, F.R.S.C.

The present condition of the grinding and polishing of the mirror and of the construction of the mounting will be described and illustrated by lantern slides.

Liquid Chlorine as a Solvent: Cryoscopic Measurements at Low Temperatures: P. WAENTIG and D. MCINTOSH, F.R.S.C.

Determinations of the lowering of the freezing point of chlorine by various solutes were made. Toluol, chloroform and various substances forming oxonium compounds such as ether, gave normal results; bodies containing the hydroxyl group were polymerized.

The Preparation of Metallic Vanadium: R. EDSON and D. MCINTOSH, F.R.S.C.

Vanadium was deposited on a heated wire from an atmosphere of a volatile vanadium compound and hydrogen.

Bromocamphor Sulphonic Acid and Oxonium Compounds: D. MCINTOSH, F.R.S.C.

An account of an unsuccessful attempt to prepare oxonium compounds.

The Viscosity of Ethyl Ether in the Neighborhood of the Critical Point: A. L. CLARK, B.Sc., Ph.D.

A Self-recording Instrument for Measuring Earth Temperatures: JOHN PATTERSON, M.A. (Cantab). Presented by R. F. STUPART, F.R.S.C.

The instrument consists of a Thread Recorder Galvanometer and a set of thermo couples connected through a special commutator to the galvanometer. A record is obtained of the temperature at the surface and at a depth of six inches twice every hour; below six inches the record is obtained once every hour at each depth.

On the Diurnal Changes in Magnetic Horizontal Force at Agincourt, 1902–1912: W. E. W. JACKSON, M.A. Presented by R. F. STUPART, F.R.S.C.

The mean diurnal inequality for each month of the year is treated by harmonic analysis and the seasonal variations brought out, and a comparison made with seasonal variations at Kew. Finally the abnormalities in the monthly diurnal ranges during years of maximum and minimum sun spots is shown, and also the variations in the seasonal values of the Fourier coefficient with the sun spots.

Comparison of the Callendar Sunshine Receiver and the Angstrom Pyrheliometer: JOHN PATTERSON, M.A. (Cantab). Presented by R. F. STUPART, F.R.S.C.

The comparison made by the author in 1912 showed that there was a very large difference between the two instruments, and the comparison has been continued in order to find out the cause of the difference.

The Diffusion of Oxygen Through Silver: F. M. G. JOHNSON, Ph.D., F.R.S.C.

Waves in a Jet of Water: MR. OTTO MAAS. Presented by D. MCINTOSH, Ph.D., F.R.S.C.

In Section IV. (Geological and Biological Sciences), Dr. Buller, of the University of Manitoba, Winnipeg, delivered the presidential address and discussed "Micheli and the Discovery of Reproduction in Fungi." The other papers included:

A Contribution to a Knowledge of Canadian Ticks: DR. C. GORDON HEWITT, F.R.S.C.

The economic importance of many of the native species of ticks in North America as responsible agents in causing certain known and obscure diseases or pathological conditions in man and domestic animals renders a knowledge of the occurrence and distribution of the species occurring in Canada very desirable. The present paper brings together in an accessible form information collected by the author and others.

I. *A Comparison of Spore-discharge in the Uredineæ and the Hymenomycetes:* A. H. REGINALD BULLER, D.Sc., F.R.S.C.

A minute study of the discharge of sporidia from the promycelium of a rust fungus and from the basidiospores of Agarics has provided evidence that the processes of discharge in the Uredineæ and Hymenomycetes are identical in nature. (Lantern slides.)

II. *The Movements of Spirogyra:* A. H. REGINALD BULLER, D.Sc., F.R.S.C.

The free ends of *Spirogyra* filaments execute fairly rapid bending movements, the result of which is that the filaments become twined around one another so as to form wisps. The filaments in each wisp lie more or less parallel to one another. The parallel situation of the filaments in any wisp eventually facilitates scalariform conjugation. The movements therefore have a biological significance. (Lantern slides.)

On the Taxonomic Value of the Placenta: DR. ARTHUR WILLEY, F.R.S.C.

The paper discusses the relations of the various forms of placenta in the light of recent advances in mammalian embryology, with special reference to the gestation of the Canadian beaver.

Comarocystitis punctatus Billings: SIR JAMES GRANT, K.C.M.G., F.R.S.C.

A Cystidian from Ottawa.

The Cretaceous Sea in Alberta: D. B. DOWLING, F.R.S.C.

A fairly extended description of the formations underlying the plains is available in the several reports that have been made by various observers. The beds composing these formations have been examined in many localities and the animal re-

mains that have been found indicate the character of the medium of distribution. Some of the deposits suggest the presence for a time of a wide shallow muddy sea. Others are evidently near-shore deposits with remains of brackish-water or even fresh-water life. The final retreat of the sea from the central part of the continent is marked by a series of brackish-water deposits covered by material that has been distributed by fresh-water streams or in lakes.

In the western part of Alberta there are indications that the western margin of the marine invasion can be located and that there was at various periods a distinct narrowing of the sea so that land areas appeared which occupied portions of the present area of western Alberta. An attempt at defining the western margin of the Cretaceous sea at successive stages is made in the paper. This shows graphically in the retreat of the sea the inauguration of a period of unrest which later culminated in the elevation of this part far above the sea and finally in the formation of the Rocky Mountains.

Notes on some hitherto Unrecorded Occurrences in British Columbia, of Uncommon Minerals, Collected by the late W. J. Sutton, of Victoria: R. W. BROCK, F.R.S.C.

The late W. J. Sutton, of Victoria, made an extensive private collection of rocks and minerals. In it are a number of specimens of minerals from British Columbia, whose occurrences have not as yet been brought to the attention of the scientific world. Mr. Sutton, no doubt, would have described these in detail; the writer can only mention such as he noticed, but places them before the society in order that they may be credited to this earnest and enthusiastic mineralogist and geologist.

A British Columbia Example of the Contact Metamorphism of a Granite Rock to a Garnet: R. W. BROCK, F.R.S.C.

Contact metamorphism is a common phenomenon in British Columbia. Limestone, here as elsewhere, is the rock which most frequently shows pronounced effects of this process. In the Boundary Creek District, while this is also the case, other rocks have been affected in like manner, though the late S. F. Emmons and other authorities who visited the Boundary Creek District have expressed the opinion that such alteration was confined to the limestones. An unequivocable instance of the alteration of granodiorite occurs on Pass Creek, as mentioned by the writer in the Summary Report of the Geological Survey for 1902. Although other instances of somewhat similar occurrences are now generally recognized and accepted, this occurrence is deemed worthy of a more extended description than it received in the Summary Report above mentioned, as being one of the most definite and striking examples of such metamorphosis yet found.

The Upper Limit of Temperature Compatible with Life in the Frog: A. T. CAMERON and T. I. BROWNLEE. Presented by DR. SWALE VINCENT, F.R.S.C.

Frogs (*R. pipiens*) will endure an (internal) temperature of 28° C. for several hours. A temperature of 30° C. is fatal in six hours. Death is apparently produced through some coordinating mechanisms in the central nervous system, since the individual tissues (striped muscle, heart, peripheral nerve and brain and cord) survive, and are only killed by distinctly higher temperatures. The results are therefore in line with those found by the authors of the lower limit of temperature compatible with life.

On an Accumulation of Gas in the Tissues of the Frog as a Result of Prolonged Submersion in Water: A. T. CAMERON and T. I. BROWNLEE. Presented by DR. SWALE VINCENT, F.R.S.C.

Frogs (*R. pipiens*) submerged completely in running water, but free to move, survive, on the average seven days, though individuals may survive three weeks. About two days before death they commence to swell, and rapidly become so buoyant that they can not any longer dive. The cause of death appears to be connected with this distension, which is caused by gas, distributed throughout the body and all tissues. The gas is almost pure nitrogen, and may amount in volume to 15 c.c. or over.

On the Relative Importance to Life of the Cortex and the Medulla of the Adrenal Bodies: T. D. WHEELER and SWALE VINCENT, F.R.S.C.

As the result of a long series of experiments upon dogs, cats and rabbits, in which the medulla was removed as completely as possible (without inflicting more than an unavoidable damage to the cortex), it would appear that the cortex is the part which is essential to life, and that the chromaphil tissue constituting the medulla can be entirely removed without any serious results.

A Study of some Organisms which Produce Black Fields on Æsculin-bilesalt Media: F. C. HARRISON, D.Sc., F.R.S.C.

In the summer of 1913 more than 4,000 Æsculin-bilesalt agar plates were made from samples of

milk obtained from more than a thousand different dealers or farmers in the province of Quebec.

Seven hundred colonies from these plates were selected for further study, and we found 11 organisms which developed black fields in less than 48 hours on æsculin-bilesalt media at blood heat, and which did not belong to the colon-aerogenes group. These organisms came from the vicinity of Huntingdon, Quebec, but could not be isolated from milk obtained from this district the following spring.

By keeping the æsculin-bilesalt agar plates at room temperature for at least five days, more exceptions appeared, seven of which were carefully studied.

The Harrison-Barlow Nitrocultures and their Commercial Application: F. C. Harrison, D.Sc., F.R.S.C.

At the meeting of the Royal Society held in May, 1906, Harrison and Barlow read a paper on the "Nodule Organism of the Leguminosæ—Its Isolation, Cultivation, Identification and Commercial Application." Since that date large numbers of the so-called nitro-cultures prepared according to the directions given in the above mentioned paper were distributed to farmers in Canada and the United States. This paper gives a short account of the commercial application of these nitro-cultures between 1906 and 1914.

The Diatoms of the Coast of Vancouver Island, B. C.: Dr. L. W. Bailey, F.R.S.C., and Dr. A. H. MacKay, F.R.S.C.

So far as known to the writers of this paper no publications relating to the diatoms of the Pacific Coast of Canada have as yet been made. The establishment of one of the stations of the biological board of Canada at Nanaimo, B. C., having made it possible to obtain materials for the study of these organisms, some of the results of that study are here presented in preliminary form.

The total number of species so far identified is over 250, of which a list, with diagnostic measurements, is given. Of these several are believed to be new. The characteristics of the phytoplankton are distinctly indicated and comparisons are drawn between those of the Pacific and Atlantic coasts, as well as those of the North Sea and the Antarctic, to the latter of which the Vancouver collections bear interesting resemblances.

Metallogenetic Epochs in the Pre-Cambrian of Ontario: Willet G. Miller, F.R.S.C., and Cyril W. Knight.

During the vast period represented by the pre-Cambrian rocks of Ontario ore deposits were formed at various epochs. Knowledge of the pre-Cambrian gained during the last decade furnishes a means of correlating these ore deposits as regards their age and genetic relations.

Modes of Occurrence of some Gold-bearing Veins in the Pre-Cambrian Rocks of Canada: J. B. Tyrrell, F.R.S.C.

For nearly fifty years gold has been known to occur in mineral veins in the pre-Cambrian rocks of Central Canada. While the great majority of these occurrences have been too small or poor to allow of mining and milling at a profit, the rich and extensive gold-bearing veins found within the last few years in northern Ontario show that all the gold prospects in the country are not "Will-o-the-wisps" which exist only for the purpose of enticing eager and unwary investors to destruction.

In the present paper the author attempts to give a brief outline of the character of the mineral veins in the pre-Cambrian rocks of central and northern Canada in which gold has been found; the modes of occurrence of gold in these veins, and the character of the rocks which form their walls, or which are sufficiently near to suggest some genetic relationship between them.

A New Myxobacterium: J. H. Faull, Ph.D., F.R.S.C.

The microorganisms of this form heap up, organizing a stalked, branched or unbranched, one to several-headed fruiting body. On the heads columnar or conical cysts develop, on the surfaces of which a membrane is secreted. From these cysts, the bacteria later migrate into the main body of the head, the husks of the cysts persisting as shrivelled and twisted curls. The species exhibits a remarkable variability in respect to the morphological features of its fruiting bodies. It stands out as one of the most highly specialized of the order to which it belongs.

Some Anatomical Features of Willow Galls and their Significance: A. Cosens, M.A., Ph.D., and T. Sinclair, M.A. Presented by J. H. Faull, Ph.D., F.R.S.C.

A study of the anatomy of certain willow galls led to the discovery of a well-defined aeriferous tissue which is not present in the corresponding regions of normal plants. A search for this tissue in normal plants led to its discovery in primitive areas or "vestige-carriers." Various experiments were made with negative results, to see if this tissue could not be induced by changing the environment. The conclusions reached are: (1) that

this is a primitive tissue in the willows and not a modification of the normal tissues due to changed environment; (2) that the reinstatement, under stimulus of vestigial characteristics in a plant has an important bearing on the question of gall production, for the gall producer not only exercises directive control over the active characteristics of the protoplasm, but over dormant as well. Under these conditions, unexpected structures and unusual combinations may well be produced.

On a Pre-Cambrian Outlier in Central Manitoba: PROFESSOR R. C. WALLACE. Presented by A. H. REGINALD BULLER, D.Sc., F.R.S.C.

The Swarming of Ondotosyllis: C. MCLEAN FRASER, Ph.D. Presented by A. B. MACALLUM, Ph.D., F.R.S.C.

Bibliography of Canadian Botany for the Year 1914: DR. A. H. MACKAY, F.R.S.C.

Bibliography of Canadian Geology for 1914: WYATT MALCOLM. Presented by R. G. MCCONNELL, B.A., F.R.S.C.

Bibliography of Canadian Entomology for the Year 1914: REV. C. J. S. BETHUNE, D.C.L., F.R.S.C.

Bibliography of Canadian Zoology for the Year 1914 (Exclusive of Entomology): E. M. WALKER, B.A., M.B.

HENRI M. AMI

SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-second summer meeting of the society was held at the University of California on Tuesday and at Stanford University on Wednesday, August 3–4, 1915, in connection with the Panama-Pacific International Exposition, thirty-four members being in attendance. Professor M. W. Haskell, chairman of the San Francisco section, presided on Tuesday afternoon, and Professor R. E. Allardice at that on Wednesday afternoon.

Tuesday morning was devoted to a joint session with the American Astronomical Society and Section A of the American Association for the Advancement of Science. Addresses were delivered by Professors C. J. Keyser on "The human significance of mathematics," and G. E. Hale on "The work of a modern observatory." The astronomers, mathematicians and physicists lunched at the Faculty Club as guests of Professors Leuschner, Haskell and E. P. Lewis.

The social program included a dinner with the American Astronomical Society at the Hotel Oakland on Wednesday evening, an excursion to the Lick Observatory on Friday, and a luncheon given by Mrs. Phoebe Hearst at the Hacienda del Pozo de Verona on Saturday.

The following papers were read at this meeting:

L. E. Dickson: "Invariantive classification of pairs of conics modulo 2."

C. J. de la Vallée Poussin: "Sur l'intégrale de Lebesgue."

A. R. Schweitzer: "On the solution of a class of functional equations."

Nathan Altshiller: "On the circles of Apollonius."

Dunham Jackson: "Proof of a theorem of Haskins."

W. W. Küstermann: "Fourier constants of functions of two variables."

B. A. Bernstein: "A set of four independent postulates for the logic of classes."

G. A. Miller: "Limits of the degree of transitivity of substitution groups."

R. D. Carmichael: "On the representation of numbers in the form $x^3 + y^3 + z^3 - 3xyz$."

H. S. White: "Seven points on a gauche cubic curve."

M. W. Haskell: "The del Pezzo quintic curve."

L. J. Richardson: "A phase of Roman mathematics."

C. A. Fischer: "Functions of surfaces with exceptional points or curves."

A. R. Williams: "On a birational transformation connected with a pencil of cubics."

F. N. Cole: "Note on the triad systems in 15 letters."

A. B. Coble: "The determination of the lines on a cubic surface."

H. S. Vandiver: "An aspect of the linear congruence, with applications to the theory of Fermat's quotient."

C. H. Forsyth: "An interpolation formula based upon central and multiple differences."

G. M. Green: "On isothermally conjugate nets of space curves."

L. P. Eisenhart: "Surfaces of rolling and transformations of Ribaucour."

A. R. Schweitzer: "Generalized quasi-transitive functional relations."

L. M. Hoskins: "'Quantity of matter' in dynamics."

A. A. Bennett: "The iteration of functions of one variable."

The next meeting of the society will be held in New York, on October 30.

F. N. COLE,
Secretary

SCIENCE

Friday, October 8, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PACIFIC COAST MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

In its sixty-seventh year the American Association for the Advancement of Science reached the Pacific coast after wandering in previous years to all the principal cities of the east and central west of the United States and Canada, on one occasion venturing as far west as Denver. The California meeting is thus memorable in itself as marking an epoch in the history of our association as well as for its coincidence with the superb Panama-Pacific Exposition of the practical, educational and artistic development of the world.

It is not too much to say that this meeting of the association was an event of real importance in the scientific development of our country. While the exposition is in a measure a summary of the world's progress in the arts and applied sciences from the time when the great westward migration began from Asia some 25,000 or 30,000 years ago, our association meeting was very wisely planned throughout to bear chiefly a Pacific-coast and Pacific-ocean character. This field in itself is a very large one, and it was broadened by including the relations which the Pacific region in general bears to other parts of the world.

All of the members, and especially those who had not visited the Pacific coast before, arrived with a keen spirit of interest in the scientific wonders of the great state of California, its past history, the records which its very able men of science have established in every branch, the problems which confront the present generation, and

last but not least in the work of the body of talented young men and women who are now entering science from the two great universities and other educational institutions of the state. In no other region is the outlook for the advancement of science more encouraging.

The admirable handbook "Nature and Science on the Pacific Coast," written in collaboration by thirty-one specialists, was quite widely distributed prior to as well as at the meeting and thoroughly prepared the members of the association for the general understanding of the geography, the history, the geology and physiography, the climate, the past and present animal and plant life, the economic and educational development of California. The preparation of this booklet was a felicitous idea and it developed into a most tasteful and interesting volume under the chairmanship of Professor John C. Merriam. Similarly Director George Otis Smith of the United States Geological Survey prepared for the westward journey of members of the association by projecting a series of historic and geologic guidebooks of the western United States, one for each of the great transcontinental railway routes. The first of these volumes, which is entitled "Part B, The Overland Route with a Side Trip to Yellowstone Park," written by Messrs. Lee, Stone, Gale and others of the survey, furnished a guide along the Union and Southern Pacific Railways from Omaha west. These several volumes can not be too highly praised; beside affording a clear introduction to the scientific aspects of the country en route they contain a great deal of information of permanent value.

We do not recall any previous meeting of the association for which such prolonged, intelligent and self-sacrificing attention has been devoted to preparation, to the scientific programs and to the scientific excursions. The whole endeavor was worthy both of the memorable event which took the association to California and of the very high scientific standards which have been established in the state. This preparation also reflected the very cordial spirit of cooperation which now unites scientific men of all parts of the Pacific coast. Those of us from other states who were fortunate enough to be present at this admirably planned meeting can hardly find words to express our appreciation of the labors of the various committees, which were composed of many of the leading men and women of the Pacific coast states as well as of our eastern possessions in the Pacific, Hawaii and the Philippines.

Among the leaders during two years of almost unceasing preparation were the president of the association, Director W. W. Campbell of the Lick Observatory, who served as chairman of the executive committee as well as of the Pacific Coast committee, the latter committee including most of the prominent scientific men of the Pacific Coast states. Another very active member was Professor Merriam, paleontologist of the University of California, who ably cooperated with President Campbell for the general welfare of the association but especially in the arrangement of the programs of the Geological and Paleontological Societies. The newly elected president of Stanford University, Professor John C. Branner, served as the head of the committee on scientific program. Among the many ladies who took an active interest in the social features of the meeting may be mentioned Mrs. Phoebe Apperson Hearst, long a patroness of science on the Pacific coast, who took the title of honorary president of the general committee and gave a delightful afternoon reception at the Hacienda del Poso de Verona near Pleasanton.

The scientific sessions were chiefly held in the University of California, the president and faculty uniting in cordial hospitality throughout the week. Half days and evenings were partly given to visits to the Exposition. The general evening reception in the California State Building was delightfully arranged. One of the very enjoyable features of the meeting was Stanford University Day, Wednesday, August sixth, during which Ex-president Jordan, President Branner and the faculty of the university acted as hosts at Palo Alto.

The excursions were admirably arranged, extending to every part of California, and it may be said that no other state is so crowded with scientific interest. In the presence of living volcanoes, living glaciers and great recent earthquakes one finds geologic history still being written. The state is absolutely unique also in many of the features of its present abounding animal and vegetable life, especially perhaps in its forest and desert floras, and is no less unique in many features of its coastal Pacific life.

The central subject of the natural history of California, of the Pacific coast, and of the Pacific ocean naturally dominated the meetings, especially those in geology, paleontology, seismology, botany, zoology and anthropology. Thus the programs of all of the sessions, which were throughout of exceptional interest, were chiefly devoted to what may be called the science of the coast, with a lesser amount of time assigned for general papers. For the public of San Francisco three evening public addresses, also on Pacific problems, were delivered by Professor Daly of Harvard, Professor Scott of Princeton and Professor Reinsch, U. S. Ambassador to China. The geologists and paleontologists united in a series of spirited discussions on the means of determining the time relations of great events in the past history of the state of California and events in other parts of the United States and the Old World. These two societies seldom have had more important programs or a more valuable series of contributions than those presented by the leading geologists of California and by the invited geologists and paleontologists from the east. Especially noteworthy was the contribution on the correlation of the Triassic by James Perrin Smith of Stanford University. The Astronomical Society also had a full and influential meeting in joint session with Section A of the association, concluding with enjoyable excursions to the Lick Observatory and to the Mt. Wilson Observatory near Pasadena.

Taken altogether the entire program proved to be very stimulating to all those who came from other sections of the country. The broad conception of the original purposes of the association, which distinguishes our sister associations of Great Britain and the continent, was manifest throughout and rendered the Pacific Coast meeting one of the most notable and memorable in our history.

Henry Fairfield Osborn

PROCEEDINGS OF THE MEETING

The opening session of the Pacific Coast meeting of the American Association for the Advancement of Science and of affiliated societies was held on Monday morning, August 2, in the Scottish Rite Auditorium, San Francisco. At this session the following addresses were given:

Address of welcome on behalf of the Panama-Pacific International Exposition, William Henry Crocker, first vice-president of the Panama-Pacific International Exposition.

Address of welcome on behalf of the Pacific Division of the American Association for the Advancement of Science, Benjamin Ide Wheeler, president of the University of California.

Address of welcome on behalf of the institutions of learning in the Pacific region, David Starr Jordan, chancellor of Leland Stanford Junior University.

Response to the addresses of welcome, Henry Fairfield Osborn, president of the American Museum of Natural History.

Announcements, L. O. Howard, permanent secretary of the American Association for the Advancement of Science.

Address: "Science and Civilization," William Wallace Campbell, president of the American Association for the Advancement of Science.

Other general meetings of the association, as a whole, included three public evening addresses which were presented in San Francisco, also in the Scottish Rite Auditorium:

Tuesday, August 3, "Problems of the Pacific Islands," Reginald Alsworth Daly, Harvard University.

Thursday, August 5, "The Isthmus of Panama and Its Influence on the Animal Life of North and South America," William Berryman Scott, Princeton University.

Friday, August 6, "The Economic Future of the Pacific," Paul Samuel Reinsch, American Ambassador to China.

On Monday evening, August 2, a reception was tendered to the visiting scientists in the California Building on the Exposition grounds, San Francisco. On Thursday afternoon, August 5, a garden fête was prepared for the visiting ladies and for the members of the Association and of affiliated societies in an oak grove on the campus of the University of California.

The sessions of sections and of societies on Wednesday, August 4, were held at Stanford University. Over 400 members and friends of the association and affiliated societies were taken by a special train from San Francisco to Palo Alto on this occasion. After a general session for addresses of welcome and of response, luncheon was served in Memorial Court, Stanford University. The afternoon was devoted to meetings of sections and of societies. The visiting ladies were entertained at a musicale in Memorial Church, and later in the afternoon at tea in the Women's Club House. On Wednesday evening upon the return from Stanford University, dinners of several sections and societies were held as follows:

Section A, Mathematics and Astronomy, the American Mathematical Society, and the American Astronomical Society; Hotel Oakland, Oakland.

Section B, Physics, and the American Physical Society; Jules Café, San Francisco.

The Geological Society of America, the Paleontological Society, and the Seismological Society; Engineers' Club, Mechanics Institute Building, San Francisco.

Biological Society of the Pacific, jointly with visiting biologists; Hotel Sutter, San Francisco.

Section H, Anthropology and Psychology, and the American Psychological Association; Castilian Café, San Francisco.

Section H, Anthropology and Psychology, and the American Anthropological Association; Hang Far Low Café, San Francisco.

Sessions of sections and of societies on other days of the week were held at the University of California, Berkeley.

During the latter days of the week and in the week succeeding, excursions were organized as follows:

For mathematicians and astronomers to the Lick Observatory at Mount Hamilton, including a visit to the home of Mrs. Phoebe Apperson Hearst near Pleasanton.

For geologists to Hunter's Point, San Francisco, for an examination of Franciscan formation; to Point Reyes Station, Marin County, for an examination of the San Andreas fault and rift; to Lassen Peak, Shasta County, to note the recent volcanic activity of that mountain; to Mount Diablo, Contra Costa County, to examine the series of strata composing the geosyncline between the Bay of San Francisco and Mount Diablo; and to the Yosemite Valley region.

For paleontologists to the shore of San Pablo Bay to examine localities for Cretaceous, Tertiary and Pleistocene faunas; to the Mount Diablo region; to the Ricardo Pliocene beds of the Mohave Desert; to the Pleistocene asphalt deposits of Rancho La Brea near Los Angeles; and to the marine Pleistocene deposits near San Pedro.

For zoologists and botanists to Muir Woods and Mount Tamalpais, and for botanists to the

Yosemite Valley and to the Monterey Peninsula and the Carnegie Desert Laboratory at Carmel.

The sections and societies meeting independently or in conjunction with these sections upon this occasion were as follows:

Section A, Mathematics and Astronomy.
Section B, Physics.
Section F, Zoology.
Section G, Botany.
Section H, Anthropology and Psychology.
Section L, Education.
Section M, Agriculture.
Astronomical Society of the Pacific.
American Astronomical Society.
American Mathematical Society.
American Physical Society.
Geological Society of America and the Cordilleran Section.
Paleontological Society.
Seismological Society of America.
American Society of Naturalists.
American Society of Zoologists.
Biological Society of the Pacific.
Entomological Society of America.
American Association of Economic Entomologists (August 9 and 10).
Pacific Slope Association of Economic Entomologists (August 9 and 10).
American Phytopathological Society.
American Fern Society.
American Psychological Association.
American Association for the Study of the Feeble-Minded.
American Anthropological Association.
Archeological Institute of America.
American Genetic Association.
Association of American Dairy, Food and Drug Officials.

Altogether over ninety sessions of the association, of sections and of other societies were held during this week of meetings.

The total registered attendance at these meetings of members of the association or of participating societies was 606. In addition to this registration the names were given of 174 ladies accompanying members of the societies. The attendance from states and from abroad was distributed as follows:

Arizona, 7
California, 300
Colorado, 4
Connecticut, 4
Delaware, 1
Florida, 1
Idaho, 5
Illinois, 9
Indiana, 2
Iowa, 6
Kansas, 8
Louisiana, 4
Maine, 1
Maryland, 5
Massachusetts, 12
Michigan, 1
Minnesota, 9
Mississippi, 1
Missouri, 13
Montana, 4
Nebraska, 8
Nevada, 10
New Hampshire, 1
New Jersey, 5
New Mexico, 3
New York, 24
North Dakota, 2
Ohio, 9
Oklahoma, 1
Oregon, 25
Pennsylvania, 8
Rhode Island, 1
South Carolina, 1
South Dakota, 1
Tennessee, 1
Texas, 8
Utah, 9
Vermont, 1
Virginia, 1
Washington, 19
Washington, D. C., 31
West Virginia, 2
Wisconsin, 3
Wyoming, 2
Canada, 7
China, 1
Cuba, 1
Denmark, 1
England, 3
Hawaiian Islands, 8
Japan, 4
Mexico, 2
New Zealand, 1
Philippine Islands, 3
Sweden, 1
Syria, 1

ALBERT L. BARROWS,
Secretary, Pacific Division

FARMING AND FOOD SUPPLIES IN TIME OF WAR[1]

AGRICULTURE is the antithesis of warfare; farming is preeminently a peaceful avocation, and farmers are essentially men of peace. The husbandman is not easily disturbed by war's alarms, and his intimate association with the placid and inevitable processes of nature engenders a calmness of spirit which is unshaken by catastrophe. Many stories illustrative of this attitude of mind come to us from the battlefields. The complete detachment of the fighting men from the rest of the community which was usual up to quite recent times is impossible in these days when in almost every country the army is not a class but the nation. It is inconceivable now that a war could rage of which it could be said, as has been said of our civil war:

> Excepting those who were directly engaged in the struggle, men seemed to follow their ordinary

[1] Address of the president to the Agricultural Section of the British Association for the Advancement of Science, Manchester, 1915.

business and their accustomed pursuits. The story that a crowd of country gentlemen followed the hounds across Marston Moor, between the two armies drawn up in hostile array, may not be true; but it illustrates the temper of a large proportion of the inhabitants.[2]

But, while farmers and peasants within the range of the guns can not now ignore the fighting, they have repeatedly demonstrated their invincible determination that the madness of mankind shall not interrupt the calm sanity of the ordered cultivation of the soil. Of a district in the Argonne, a correspondent, writing in April last, said:

The spring seed has already been sown or is being sown, sometimes indifferently, under shell-fire, right up to the edge of the trenches.[3]

A story was told of a farmer in Flanders looking over the parapet of a trench and demanding of an indignant British officer whether any of his men had stolen his pig. On receiving a suitable reply, he observed that he had already asked the French, who also denied all knowledge of the missing animal, so that he supposed it must be those condemned Germans, whom he forthwith proceeded to interview. Such a sublime sense of values, such absorption in the things that matter, such contempt for the senseless proceedings of warfare, are only possible to the agriculturist. The quarrels of mankind are transient, the processes of nature are eternal. One thinks of Matthew Arnold's lines:

The East bowed low before the blast
In patient deep disdain;
She let the legions thunder past,
And plunged in thought again.

But, while the farmer is by instinct a pacifist, he is also, in a cause which rouses him, a doughty fighter. In that same civil war to which so many were indifferent, the farmers of East Anglia, under Cromwell, changed the course of English history; and the thoroughness with which they turned their ploughshares into swords is demonstrated by the fact that when they took to soldiering they put the nation for the first and only time under what is now termed militarism; that is, government controlled by the army. In the last battle fought on English soil the yeomen and peasants of the West Country proved, amid the butchery of Sedgemoor, that bucolic lethargy can be roused to desperate courage. Indeed, through all our island story, since the English yeomen first broke the power of medieval chivalry and established the supremacy of infantry in modern warfare, it has been from the rural districts that the nation has drawn its military strength. Even in the present war, when the armies of the empire have been drawn from all classes of the community, the old county regiments and the yeomanry squadrons with their roots in the countryside have proved once more that the peaceful rustic is as undismayed on the field of battle as on the fields of peace.

It is, however, in his pacific rather than in his belligerent aspect that the British farmer now claims our attention, and, before considering the position of farming in the present war, we may briefly glance at its position when a century ago the nation was similarly engaged in a vital struggle.

From February 1793 until 1815, with two brief intervals, we were at war, and the conflict embraced not only practically all Europe but America as well. The latter half of the eighteenth century had witnessed a revolution of British agriculture. The work of Jethro Tull, "Turnip" Townshend, Robert Bakewell, and their disciples, had established the principles of modern farming. Coke of Holkham had begun his missionary work; Arthur Young was preaching the gospel of progress; and in 1803 Humphry Davy delivered his epoch-ma-

[2] Prothero, "English Farming, Past and Present," p. 104.

[3] *Westminster Gazette*, April 30, 1915.

king lectures on agricultural chemistry. Common-field cultivation, with all its hindrances to progress, was rapidly being extinguished, accelerated by the General Inclosure Act of 1801. A general idea of the state of agriculture may be obtained from the estimates made by W. T. Comber of the area in England and Wales under different crops in 1808. There were then no official returns, which, indeed, were not started until 1866; but these estimates have been generally accepted as approximately accurate and are at any rate the nearest approach we have to definite information.

I give for comparison the figures from the agricultural returns of 1914, which approximately correspond to those of the earlier date:

	1808 Acres	1914 Acres
Wheat	3,160,000	1,807,498
Barley and rye	861,000	1,558,670
Oats and beans	2,872,000	2,223,642
Clover, rye-grass, etc.	1,149,000	2,558,735
Roots and cabbages cultivated by the plough	1,150,000	2,077,487
Fallow	2,297,000	340,737
Hop grounds	36,000	36,661
Land depastured by cattle	17,479,000	16,115,750

The returns in 1914 comprise a larger variety of crops than were cultivated in 1808. Potatoes, for instance, were then only just beginning to be grown as a field-crop, and I have included them together with Kohl-rabi and rape, among "roots and cabbages."

The population of England and Wales in 1801 was 8,892,536, so that there were 35½ acres under wheat for every hundred inhabitants. In 1914 the population was 37,302,983, and for every hundred inhabitants there were 5 acres under wheat.

The yield of wheat during the twenty years ending 1795 was estimated at 3 qrs. per acre;[4] in 1914 it was 4 qrs. per acre. The quantity of home-grown wheat per head of population was therefore 8½ bushels in 1808, and 1½ bushels in 1914. Nevertheless, even at that time, the country was not self-supporting in breadstuffs. In 1810, 1,305,000 qrs. of wheat and 473,000 cwt. of flour were imported. The average annual imports of wheat from 1801 to 1810 were 601,000 qrs., and from 1811 to 1820 458,000 qrs. Up to the last decade of the eighteenth century England was an exporting rather than an importing country, and bounties on exports were offered when prices were low, from 1689 to 1814, though none were, in fact, paid after 1792.

During the war period we are considering, the annual average price of wheat ranged from 49 s 3 d per qr. in 1793 to 126 s 6 d per qr. in 1812; the real price in the latter year, owing to the depreciation of the currency, being not more than 100 s. In 1814 the nominal price was 74 s 4 d and the real price not more than 54 s per qr.[5] The extent to which these high and widely varying prices were affected by the European war has been the subject of controversy. As we mainly depended on the Continent for any addition to our own resources, the diminished production during the earlier years in the Netherlands, Germany and Italy, and in the later years of the war in Russia, Poland, Prussia, Saxony and the Peninsula, reduced possible supplies. At the same time the rates of freight and insurance, especially in the later years of the war, increased very considerably. Tooke mentions a freight of £30 per ton on hemp from St. Petersburg in 1809. On the other hand, a powerful impetus was given

[4] Report of Select Committee on the means of promoting the cultivation and improvement of the waste, uninclosed and unproductive lands of the kingdom, 1795.

[5] Porter's "Progress of the Nation," by F. W. Hirst, p. 183.

to home production, which was stimulated by government action and private enterprise. Inclosure was encouraged by the General Inclosure Act of 1801, and 1,934 Inclosure Acts were passed from 1793 to 1815. The schemes for increasing and conserving food supplies were various. The Board of Agriculture, for example, offered prizes of 50, 30 and 20 guineas, respectively, to the persons who in the spring of 1805 cultivated the greatest number of acres—not less than 20—of spring wheat.[6] In 1795 a Select Committee recommended that bounties should be granted to encourage the cultivation of potatoes on "lands at present lying waste, uncultivated, or unproductive," and that means should at once be adopted to add at least 150,000 and perhaps 300,000 acres to the land under cultivation "as the only effectual means of preventing that importation of corn, and disadvantages therefrom, by which this country has already so deeply suffered." Another view of importation is presented by Tooke, who, in a discussion of the effect of the war, says:

> Although the war can not have been said to have operated upon the supply of agricultural produce of our own growth and other native commodities, sufficiently to outweigh the circumstances favorable to reproduction, it operated most powerfully in increasing the cost of production and in obstructing the supply of such commodities as we stood in need of from abroad. It is therefore to war chiefly as affecting the cost of production and diminishing the supply, by obstructions to importation, at a time when by a succession of unfavorable seasons our own produce became inadequate to the average consumption, that any considerable proportion of the range of high prices is to be attributed.[7]

The main cause of high prices and scarcity was the failure of the harvests. Mr. Prothero thus analyses the wheat harvests of the twenty-two years 1793–1814:

> Fourteen were deficient; in seven out of the fourteen the crops failed to a remarkable extent, namely in 1795, 1799, 1800, 1809, 1810, 1811, 1812. Six produced an average yield. Only two, 1796 and 1813, were abundant; but the latter was long regarded as the best within living memory.[8]

It appears paradoxical, but in a sense it is true, to say that the scarcity of wheat in certain years arose from the fact that the country was too largely dependent on its own crop. The risk of a bad harvest in a climate such as that of the British Isles must always be serious, and by the fortune of war this risk between 1793 and 1814 turned out to be very high. When supplies are drawn from the four quarters of the globe, it is evident that the risk of a shortage in time of peace is greatly reduced. Whether in a great war it is preferable to be more dependent on the sea than on the season is debatable.

In comparison with wars for national existence, such as that against Napoleon and in a still sterner sense that in which we are now engaged, other conflicts appear insignificant. The Crimean War, however, did affect our food supplies and had a reflex action on British agriculture. The cessation of imports from Russia caused a rise in the price of corn. The average price of wheat rose to 72s 5d per qr. in 1854, 74s 8d in 1855 and 69s 2d in 1856. Only once before (in 1839) during the previous thirty-five years had it risen above 70s. There were then no agricultural returns, but the estimates of Lawes, which were generally accepted, put the area under wheat at a little more than 4,000,000 acres, a higher figure than has been suggested for any other period. It is, indeed, highly probable that the Crimean War marked the maximum of wheat cultivation in this coun-

[6] "Annals of Agriculture," 1805.

[7] "History of Prices," ed. 1838, Vol. I., p. 116.

[8] "English Farming, Past and Present," p. 269.

try. It was a time of great agricultural activity and of rapid progress. To their astonishment, farmers had found, after an interval of panic, that the repeal of the corn laws had not obliterated British agriculture and that even the price of wheat was not invariably lower than it had often been before 1846. Caird had preached "high farming" in 1848 and found many disciples, capital was poured into the land, and the high prices of the Crimean period stimulated enterprise and restored confidence in agriculture.

To generalize very roughly, it may be said that while the Napoleonic wars were followed by the deepest depression in agriculture, the Crimean War was followed by a heyday of agricultural prosperity which lasted for over twenty years. What the agricultural sequel to the present war may be, I leave to others to estimate, and I turn to consider briefly some of its effects on British farming up to the present time.

Harvest had just begun when war broke out on August 4; indeed, in the earlier districts a good deal of corn was already cut. The harvest of 1914 was, in fact, with the exception of that of 1911, the earliest of recent years, as it was also one of the most quickly gathered. The agricultural situation may perhaps be concisely shown by giving the returns of the crops then in hand, *i. e.*, in course of gathering or in the ground, with the numbers of live stock as returned on farms in the previous June. The figures are for the United Kingdom, and I add the average for the preceding ten years for comparison:

	1914	Average 1904–13
	Qrs.	Qrs.
Wheat	7,804,000	7,094,000
Barley	8,060,000	7,965,000
Oats	20,664,000	21,564,000
Beans	1,120,000	1,059,000
Peas	374,000	525,000
	Tons	Tons
Potatoes	7,476,000	6,592,000
Turnips and swedes	24,196,000	26,901,000
Mangold	9,522,000	9,934,000
Hay	12,403,000	14,148,000
	Cwts.	Cwts.
Hops	507,000	354,000
	No.	No.
Cattle	12,185,000	11,756,000
Sheep	27,964,000	29,882,000
Pigs	3,953,000	3,805,000
Horses	1,851,000	2,059,000

Farmers had thus rather more than their usual supplies of nearly every crop, the chief deficiencies being in peas, roots and hay. The shortage of the hay-crop was, however, in some measure made up by the large stocks left from the unusually heavy crop of 1913. It was fortunate from the food-supply point of view that two of the most plentiful crops were wheat and potatoes. The head of cattle was very satisfactory, being the largest on record, and pigs were well above average. Sheep, always apt to fluctuate in numbers, were much below average, the total being the smallest since 1882 with the exception of 1913.

On the whole, it was a good year agriculturally, and the supply of home-grown produce at the beginning of the war was bountiful. Nature at any rate had provided for us more generously than we had a right to expect.

At first it appeared as if farmers were likely to be sufferers rather than gainers by the war. Prices of feeding-stuffs, especially linseed and cotton-cakes, maize-meal, rice-meal and barley-meal, rose at once, recruiting affected the labor supply, and difficulties arose in the distribution of produce by rail. With one or two exceptions, such as oats, the prices of farm produce showed but little rise for three or four months after the war began. Wheat rose about 10 per cent., barley remained about normal, cattle

by November had not risen more than 3 per cent., sheep and veal-calves showed no rise until December, while poultry was actually cheaper than usual, though eggs rose considerably. Butter rose slightly, and cheese remained about normal. Up to nearly the end of the year, in fact, it may be said generally that British farm-produce made very little more money than usual.

Meanwhile the nation began to take a keen interest in the agricultural resources of the country, and farming became the object of general solicitude. We started with great energy to improvise, in truly British fashion, the means of facing the supreme crisis of our fate, but the elementary fact at once became obvious that it is impossible to improvise food. The main farm-crops take an unreasonably long time to grow, even if the land is prepared for them, and a sudden extension of the area under cultivation is not a simple proposition. It was freely pointed out—with undeniable truth—that our agricultural system had not been arranged to meet the conditions of a great European war, and many suggestions were made to meet the emergency. Some of these suggestions involved intervention by legislative or administrative action. It was decided that any attempt violently to divert the course of farming from its normal channels would probably not result in an increased total production from the land. The agricultural consultative committee, appointed by the president of the board of agriculture on August 10, issued some excellent advice to farmers as to their general line of policy and the best means by which they could serve the nation, and this was supplemented by the board and by the agricultural colleges and local organizations throughout the country. No less than thirty special leaflets were issued by the board, but, while it may, I think, fairly be claimed that all the recommendations made officially were sound and reasonable, I should be the last to aver that farmers were universally guided by them. They do not accept official action effusively:

> Unkempt about those hedges blows
> An English unofficial rose,

and official plants do not flourish naturally in farm hedgerows. It was, however, fairly evident that patriotism would suggest an effort to obtain the maximum production from the land, and there were good reasons to think that self-interest would indicate the same course. It must be admitted, however, that during the autumn the lure of self-interest was not very apparent. Food-prices, however, at the end of the year began to rise rapidly. English wheat in December was 25 per cent. above the July level, in January 45 per cent., in February and March 60 per cent., and in May 80 per cent. Imported wheat generally rose to a still greater extent, prices in May standing for No. 2 North Manitoba 95 per cent., and No. 2 Hard Winter 90 per cent. above July level. The greater rise in imported wheat may be noted as vindicating farmers against the charge which was made against them of unreasonably withholding their wheat from the market. Cattle and sheep rose more slowly, but in March prices of both had risen by 20 per cent., and in May and June cattle had risen by about 40 per cent. Butter rose by about 20 per cent. and cheese by about 40 per cent. Milk rose little through the winter, but when summer contracts were made prices remained generally at the winter level.

British agriculture, like the British Isles, is a comparatively small affair geographically. The 47 million acres which it occupies, compared with the 80 million acres of Germany or the 90 million acres of France, and still more with the 290 million acres of the United States, represent an

area which may be termed manageable and about which one might expect to generalize without much difficulty. But, in fact, generalization is impossible. Even on the 27 million acres of farm land in England and Wales there is probably more diversity to the square mile than in any country on earth. The variations in local conditions, class of farming, and status of occupier preclude the possibility of making any general statement without elaborate qualifications. Thus whatever one might say as to the effects of the war on agriculture would be certain to be inaccurate in some districts and as regards some farmers.

There are three main agricultural groups, corn-growing, grazing and dairying. They overlap and intermingle indefinitely, and there are other important groups, such as fruit-growing, vegetable-growing, hop-growing, etc., which represent a very large share of the enterprise and capital engaged on the land. The receipts of the corn-growing farmer generally speaking were substantially increased. Probably about 50 per cent. of the wheat-crop had been sold before prices rose above 40s per quarter, and there was very little left on the farms when they reached their maximum in May. Oats rose rather more quickly, but did not reach so high a level, relatively, as wheat. Barley—owing perhaps to enforced and voluntary temperance—never made exceptional prices, and in fact the best malting barleys were of rather less than average value. There is no doubt, however, that farmers who depended mainly on corn-growing found an exceptionally good market for their crops and made substantial profits. Farmers who depended mainly on stock were less generally fortunate, although stock were at a fairly high level of price when the war began. Sheep for some time showed no signs of getting dearer, but in the spring prices rose substantially, and a good demand for wool—which in one or two cases touched 2s per lb.—made the flockmasters' returns on the whole very satisfactory. Cattle followed much the same course; stores were dear, but by the time fat stock came out of the yards or off the grass prices had risen to a very remunerative level. The large demands on imported supplies of meat for the British and French armies occasioned a distinct shortage for the civil population, but this was relieved by a reduced demand, so that the effect upon prices of native beef and mutton was not so great as might have been expected. The influence of a rise of price upon demand is more marked in the case of meat than in that of bread. While there has been a distinct reduction in the consumption of meat, there is no evidence of a reduced consumption of bread.

Dairy farmers generally found themselves in difficulties. Prices of butter and cheese increased but slightly, and milk remained for a considerable period almost unchanged. The rise in the prices of feeding-stuffs and the loss of milkers aggravated their troubles. An actual instance of the position in February as affecting a fairly typical two-hundred acre farm may be quoted. It had thirty milch cows producing about 16,500 gallons per annum. The cake bill showed an advance of fifty per cent., and wages had risen twelve per cent. It was calculated that the extra cost was 1.3 d per gallon of milk. Later the prices of milk, butter and cheese rose, but on the whole it can not be said that dairy farmers generally made exceptional profits.

While it is certain that the gross receipts by farmers were substantially increased, it is very difficult to estimate what the net pecuniary gain to agriculture has been. It can only be said generally that while some have made substantial profits, which were probably in very few cases excessive, many others have

on balance (after allowing for extra cost) done no better financially, and some perhaps even worse, than in an average year of peace. With regard to one item of extra cost, that of labor, it is possible to make an approximate estimate. Agricultural laborers were among the first to respond to the call for the new armies, and, up to the end of January, fifteen per cent. had joined the forces of the Crown. This considerable depletion of labor was not acutely felt by farmers during the winter, but during the spring and summer serious difficulty was experienced and many devices were suggested—some of which were adopted—for meeting it. Naturally the wages of those agricultural laborers who were left rose, the rise varying in different districts but being generally from 1s 6d to 3s per week. Owing to the rise in the price of commodities, this increase of wages can not be regarded as a profit to the laborers, but it is, of course, an outlay by farmers, which in England and Wales may be reckoned as amounting to an aggregate of about £2,000,000.

This country has never suffered from a dearth of agricultural advisers, and in such a time as the present, when every one is anxious to help the country, it is natural that they should be unusually plentiful. Advice was freely offered both to the government how to deal with farmers and to farmers how to deal with the land. Whether in consequence of advice or in spite of it, it may fairly be said that farmers throughout the United Kingdom have done their duty. They have met their difficulties doggedly and have shown an appreciation of the situation which does credit to their intelligence. It was not easy last autumn when farmers had to lay their plans for the agricultural year to forecast the future. We were all optimists then, and many thought that the war might be over before the crops then being planted were reaped. It was clear, however, that the national interest lay in maintaining and, so far as possible, increasing the produce of the land. In the quiet, determined way which is characteristic of them, farmers devoted themselves to the task, and the returns recently issued give the measure of their achievement. They have added twenty-five per cent. to the acreage of wheat and seven per cent. to the acreage of oats, and they have kept the area of potatoes up to the high and sufficient level of the previous year. These are the three most important crops. They have also not only increased the stock of cattle, which was already the largest on record, but, in spite of unfavorable conditions and a bad lambing season, they have increased the stock of sheep. In view of these facts, I venture to say that British and Irish farmers have shown both patriotism and intelligence, and may fairly claim to have contributed their share to the national effort.

The share of British agriculture in the food supply of the nation is more considerable than is sometimes realized. When I last had the honor to address the British association I ventured to emphasize this point, and I may be allowed to repeat, in a somewhat different form and for a later period, the figures then given. Taking those articles of food which are more or less produced at home, the respective proportions contributed by the United Kingdom, the rest of the Empire, and foreign countries were on the average of the five years 1910-14 as given in the table.

The war has directly affected some of our food supplies by interposing barriers against the exports of certain countries. Fortunately we were in no way dependent for any of these foods upon our enemies, though Germany was one of our main sources of supply for sugar. We received

	United Kingdom, Per Cent.	British Empire Overseas, Per Cent.	Foreign Countries, Per Cent.
Wheat	19.0	39.3	41.7
Meat	57.9	10.7	31.4
Poultry	82.7	0.2	17.1
Eggs	67.6	0.1	32.3
Butter (including margarine)	25.1	13.3	61.6
Cheese	19.5	65.4	15.1
Milk (including cream)	95.4	0.0	4.6
Fruit	36.3	8.0	55.4
Vegetables	91.8	1.1	7.1

some small quantities of wheat or flour and of eggs from Germany, Hungary and Turkey, some poultry from Austria-Hungary, and some fruit from Germany and Turkey, but the whole amount was insignificant. The practical cessation of supplies from Russia was the most serious loss, as we drew from thence on an average 9 per cent. of our wheat, 9 per cent. of our butter and 16 per cent. of our eggs.

The rather humiliating panic which took possession during the first few days of the war of a certain section of the population, who rushed to accumulate stores of provisions, arose not only from selfishness but from insufficient appreciation of the main facts about food supplies. Our large imports of food are constantly dinned into the ears of the people, but the extent and possibilities of our native resources are practically unknown. It is very natural, therefore, that the man in the street should assume that even a temporary interruption of oversea supplies would bring us face to face with famine.

Within the first few days of the war, the government, through the board of agriculture, obtained returns not only of the stocks of all kinds of food-stuffs in the country but also of the stocks of feeding-stuffs for animals and of fertilizers for the land. Powers were taken under the articles of commerce (returns, etc.) act to compel holders of stocks to make returns, but it is due to the trading community to say that in only two instances, so far as the board of agriculture was concerned, was it necessary to have recourse to compulsion. The returns of stocks of food-stuffs, feeding-stuffs and fertilizers have been made regularly to the board of agriculture[9] every month since the outbreak of war, and the loyal cooperation of the traders concerned deserves cordial recognition by those whose official duty has been rendered comparatively easy by their assistance. I may be allowed to add that the readiness with which traders communicated information which was, of course, of a very confidential nature, displayed a confidence in government departments which they may regard with some satisfaction.

A very casual glance at the national dietary suffices to show that John Bull is an omnivorous feeder, and as the whole world has eagerly catered for his table his demands are exigent. But, for various reasons, our daily bread, reluctant though most of us would be to be restricted to it, is regarded as the measure and index of our food supplies. On the 4th of August the board of agriculture published an announcement that they estimated the wheat-crop then on the verge of harvest at 7,000,000 quarters, and that, including other stocks in hand, there was at that time sufficient wheat in the country to feed the whole population for four months; and a few days later, having then obtained further information from about 160 of the principal millers, they stated that the supplies in the country were sufficient for five months' consumption. The board also announced, on August 5, that the potato crop would furnish a full supply for a whole

[9] Returns in Scotland and Ireland are made to the Agricultural Departments of those countries and the results transmitted to the Board of Agriculture and Fisheries.

year's consumption without the necessity for any addition from imports. When it was further announced that the government had taken steps to ensure against a shortage of sugar it began to be generally realized that at any rate the country was not in imminent danger of starvation. Indeed, on a broad survey of the whole situation, it was apparent that our native resources, together with the accumulated stocks of various commodities held in granaries, warehouses and cold stores, would enable the United Kingdom to face even the unimaginable contingency of a complete blockade of all its ports for a considerable period.

Nevertheless it was abundantly evident, not only to the man in the street, but even to those whose duty it was to consider such matters, that the maintenance of regular supplies was essential to avoid undue depletion of stocks. The risk that a certain number of vessels carrying food to this country might be sunk by the enemy was obvious, and it was at first very difficult to measure it. After a year of strenuous endeavor by the enemy it is satisfactory to record that, although a few cargoes of food-stuffs have been sunk, the effect on supplies has been practically negligible.

Under these circumstances it appeared that, provided adequate protection were given against unusual risks, commercial enterprise might in the main be relied upon to supply the demands of the people in the normal manner and in the usual course of business. It is a self-evident axiom that it is better not to interfere in business matters unless there is a paramount necessity for interference.

The machinery of modern business in a highly organized community is very complicated; the innumerable cog-wheels are hidden while the machine is running normally, but every single one of these becomes very obvious when you attempt to introduce a crowbar. With one or two exceptions the purveyors of food to the nation were left to conduct their business without official interference, though the board of trade took steps to ascertain what were the retail prices justified by the wholesale conditions and to disseminate the information for the protection of consumers against unreasonable charges.

One measure of a drastic and widespread nature was adopted. The exportation of a large number of commodities was prohibited. This was done for two reasons: (1) to conserve stocks in this country, and (2) to prevent goods from reaching the enemy. The latter object could be attained only very partially by this method so long as any sources of supply other than the ports of the United Kingdom were open to the enemy or to adjoining neutral countries. The former object—with which we are now only concerned—was on the whole achieved. The board of agriculture, concerned for the maintenance of our flocks and herds, at once secured a general prohibition of the exportation of all kinds of feeding-stuffs for animals. Many kinds of food-stuffs were at once included and later additions were made, so that for a long time past nearly all kinds of food have been included, though in some cases the prohibition does not apply to the British Empire or to our Allies. The exportation of fertilizers, agricultural seeds, binder twine and certain other commodities more or less directly connected with the conservation of our food supplies, was also prohibited, so that generally it may be said that the outlet for any food in the country was under effective control. This is not the time or place to discuss the reasons why in some instances limited quantities of certain articles were allowed to escape under license. It is only necessary to remark that in all such cases

there were cogent reasons in the national interest for the action taken.

Direct government intervention in regard to food supplies was limited to three commodities—sugar, meat and wheat. In the case of sugar the whole business of supply was taken over by the government—a huge undertaking but administratively a comparatively simple one, owing to the fact that there are no home-grown supplies. Intervention in the meat trade was necessitated by the fact that the enormous demands of the allied armies had to be met by drafts upon one particular kind of meat and mainly from one particular source. The board of trade cooperated with the war office, and a scheme was evolved whereby a very large part of the output of meat from South America and Australia comes under government control.

As regards wheat, the intervention of the government took two forms. The scheme whereby the importation of wheat from India was undertaken by the British government, in cooperation with the Indian government, arose primarily from conditions in India rather than from conditions in the United Kingdom, although it is hoped and believed that the results will prove to be mutually advantageous. Other than this the intervention of the government in regard to wheat was devised as an insurance against the risk of interruption of normal supplies, its main object being to prevent the stocks of wheat in the country from falling to a dangerous level at a time when the home crop would be practically exhausted. When the home crop is just harvested there are ample reserves in the country for some months, and, as the United States and Canada are at the same time selling freely, stocks held by the trade are usually high. While home-grown wheat remains on the farms it is practically an additional reserve supplementary to the commercial reserves. When it leaves the farmers' hands, even although it may not actually go into consumption, it becomes part of the commercial reserve. This reserve in the nature of business tends to be constant, but fluctuates within rather wide limits under the influence of market conditions. If the price of wheat rises substantially and the capital represented by a given quantity increases, there is a natural tendency to reduce stocks. If also there is any indication of a falling market ahead, whether from favorable crop prospects or the release of supplies now held off the market for any reason, a prudent trader reduces his stocks to the smallest quantity on which he can keep his business running. So long as shipments reach this country, as in normal times they do, with, as a member of the Baltic once expressed it to me, "the regularity of buses running down Cheapside," the country may safely rely on receiving its daily bread automatically. But if any interruption occurred at a time when the trade, for the reasons just indicated, happened to be running on low stocks, the margin for contingencies might be insufficient. I am, of course, debarred from discussing the method adopted or the manner in which the scheme was carried out, but, as the cereal year for which it was devised is over, it is permissible to state that the object in view was successfully achieved.

Of the 47,000,000 people who form the population of the United Kingdom the large majority are absolutely dependent for their daily food on the organization and regular distribution of supplies. The countryman, even if he possesses no more than a pig and a garden, might exist for a short time, but the town-dweller would speedily starve if the organization of supplies broke down. He does not, perhaps, sufficiently realize the intricacy of the commercial arrangements which make up that organiza-

tion, or the obstacles which arise when the whole economic basis of the community is disturbed by a cataclysm such as that which came upon us thirteen months ago. The sorry catchword "business as usual" must have sounded very ironically in the ears of many business men confronted with unforeseen and unprecedented difficulties on every side. The indomitable spirit with which they were met, the energy and determination with which they were overcome, afford further evidence of that which has been so gloriously demonstrated on land and sea, that the traditional courage and grit of the British race have not been lost.

To the question how have our oversea food supplies been maintained during the first year of the war, the best answer can be given in figures.

Imports of the principal kinds of food during the first eleven months of the war were as under, the figures for the corresponding period of 1913–14 being shown for comparison:

	1914–15, Thousands of Cwts.	1913–14, Thousands of Cwts.	Increase + or Decrease – Per Cent.
Wheat (including flour)	113,797	113,398	– 1.39
Meat	15,868	18,026	–11.97
Bacon and hams	7,452	5,975	+24.72
Cheese	2,766	2,386	+15.93
Butter (including margarine)	5,376	5,748	– 6.47
Fruit	18,830	17,512	+ 7.53
Rice	9,573	4,840	+97.79
Sugar	35,029	38,356	– 8.67

In total weight of these food-stuffs, the quantity brought to our shores was rather larger in time of war than in time of peace. Yet one still occasionally meets a purblind pessimist who plaintively asks what the navy is doing. This is a part of the answer. It is also a measure of the success of the much-advertised German "blockade" for the starvation of England. So absolute a triumph of sea-power in the first year of war would have been treated as a wild dream by the most confirmed optimist two years ago. The debt which the nation owes to our sailor-men is already immeasurable. That before the enemy is crushed the debt will be increased we may be assured. The crisis of our fate has not yet passed, and we may be called upon to meet worse trials than have yet befallen us. But in the navy is our sure and certain hope.

That which they have done is but earnest of the things that they shall do.

Under the protection of that silent shield the land may yield its increase untrodden by the invading foot, the trader may pursue his business undismayed by the threats of a thwarted foe, and the nation may rely that, while common prudence enjoins strict economy in husbanding our resources, sufficient supplies of food will be forthcoming for all the reasonable needs of the people.

R. H. REW

THE MANCHESTER MEETING OF THE BRITISH ASSOCIATION

IN an account of the meeting *Nature* states that the number of members and associates (1,438), although satisfactory in the circumstances, was small as compared with previous meetings. But it is said that the section rooms were well filled both in the morning and afternoon sittings, and the proceedings were of exceptional interest.

The reception by the Lord Mayor in the School of Technology on Wednesday evening was the only general social function of the week, but being fixed on the second day of the meeting it gave a welcome opportunity to members to meet their friends as well as to inspect the machinery, appliances and lecture-rooms with which this great institution is equipped. The arrangements made by the committee for the visits of members to factories, warehouses, municipal undertakings and various places of special interest in Manchester and district worked well, and the short excursions were well attended. The citizen's lectures given in Manchester and other towns

in the neighborhood attracted large audiences. The subjects dealt with were: "Evolution and War," by Professor F. W. Gamble; "The Strategic Geography of the War," by Dr. Vaughan Cornish; "The Making of a Big Gun," by Dr. W. Rosenhain; "Daily Uses of Astronomy," by Mr. A. R. Hinks; "Health Conditions in the Modern Workshop," by Professor B. Moore; "Formation of the Sun and Stars," by the Rev. A. L. Cortie; "Some Lessons from Astronomy," by Professor H. H. Turner; and on "Curiosities and Defects of Sight," by Dr. W. Stirling, professor of physiology in the University of Manchester.

Grants of money appropriated for scientific purposes on behalf of the general committee are given below. The names of members entitled to call on the general treasurer for grants are prefixed to the respective committees. Of the forty-one committees receiving grants, only five are new.

SECTION A—MATHEMATICAL AND PHYSICAL SCIENCE

	£
Professor H. H. Turner—Seismological observations	180
Sir W. Ramsay—Tables of constants	40
Professor M. J. M. Hill—Mathematical tables.	35

SECTION B—CHEMISTRY

Professor H. E. Armstrong—Dynamic isomerism	20
Professor F. S. Kipping—Aromatic nitroamines	10
Mr. A. D. Hall—Plant enzymes	10
Professor H. E. Armstrong—Solubility phenomena	5
Professor H. E. Armstrong—Eucalypts	30
Professor Orme Masson—Influence of weather conditions on nitrogen acids in rainfall and atmosphere	20
Professor W. J. Pope—Crystalline form and molecular structure	10
Dr. F. D. Chattaway—Non-aromatic diazonium salts	8
Sir J. J. Dobbie—Absorption spectra, etc.	10

SECTION C—GEOLOGY

Professor Grenville Cole—Old red sandstone rocks of Kiltorcan	7
Professor W. W. Watts—Critical sections in Paleozoic rocks	20
Professor P. F. Kendall—List of characteristic fossils	10
Dr. J. Horne—Old red sandstone rocks at Rhynie	25
Dr. R. Kidston—Lower Carboniferous flora at Gullane	8

SECTION D—ZOOLOGY

Dr. A. E. Shipley—Belmullet Whaling Station.	25

SECTION E—GEOGRAPHY

Sir C. P. Lucas—Conditions determining selection of sites and names for towns	15

SECTION F—ECONOMIC SCIENCE AND STATISTICS

Professor J. H. Muirhead—Fatigue from economic standpoint	40
Professor W. R. Scott—Industrial unrest	20
Professor W. R. Scott—Women in industry	90
Professor W. R. Scott—Effects of war on credit, etc.	25

SECTION G—ENGINEERING

Professor J. Perry—Complex stress distributions	40
Dr. Dugald Clerk—Gaseous explosions	50
Dr. H. S. Hele-Shaw—Engineering problems affecting prosperity of the country	10

SECTION H—ANTHROPOLOGY

Sir C. H. Read—Age of stone circles	25
Professor G. Elliot Smith—Physical characters of ancient Egyptians	15
Dr. R. R. Marett—Paleolithic site in Jersey	25
Professor J. L. Myres—Archeological investigations in Malta	10
Professor J. L. Myres—Distribution of Bronze age implements	5

SECTION I—PHYSIOLOGY

Sir E. Schäfer—Ductless glands	20
Professor C. S. Sherrington—Mammalian heart.	20

SECTION K—BOTANY

Professor F. O. Bower—Cinchona Station, Jamaica	12
Professor F. W. Oliver—Structure of fossil plants	2
Professor F. F. Blackman—Heredity	45

SECTION L—EDUCATION

Professor J. A. Green—Museums	15
Dr. G. A. Auden—School books and eye-sight.	5
Dr. C. S. Myers—Mental and physical factors.	20

Mr. C. A. Buckmaster—"Free-place" system.	10
CORRESPONDING SOCIETIES COMMITTEE	
Mr. W. Whitaker—For preparation of report.	25
Total	£968

SCIENTIFIC NOTES AND NEWS

DR. EDMUND B. WILSON, Da Costa professor of zoology, gave the annual address at the opening exercises of Columbia University on September 29, his subject being "Science and Education."

DEAN FREDERICK J. WULLING, of the College of Pharmacy of the University of Minnesota, was chosen president of the American Pharmaceutical Association, which held a session in San Francisco in August.

DR. THEOBOLD SMITH, director, and other members of the staff of the Rockefeller Institute for the Study of Animal Diseases which is being built near Princeton at a cost in the neighborhood of a million dollars, have started their work in a suite of four rooms loaned by the biology and geology departments of Princeton University. The buildings of the institute will be on a tract of 480 acres, lying near the Walker-Gordon farms and are expected to be completed within a year.

DR. A. F. BLAKESLEE, professor of botany and genetics, has taken up his work as plant geneticist at the Carnegie Institution Station for Experimental Evolution at Cold Spring Harbor, where he succeeds Dr. George H. Shull, who has become professor of botany at Princeton University.

THE Field Museum of Natural History announces the appointment of Dr. Berthold Laufer as curator of anthropology to succeed Dr. George A. Dorsey, resigned.

MR. W. G. CRAIB, assistant for India in the Kew Herbarium, has been appointed assistant to the professor of botany in the University of Edinburgh. Mr. J. Hutchinson succeeds Mr. Craib at the Royal Gardens.

R. A. JEHLE has been appointed plant pathologist of the Florida Plant Board. His work will be investigation of citrus canker, a serious disease of citrus fruits, which was probably introduced into the United States from Japan a few years ago. His address will be Homestead, Florida.

PROFESSOR W. S. FRANKLIN will make a tour of the universities and technical schools of the south and west during the coming fall and winter; and he offers to give, in connection with this trip, a number of theoretical and experimental lectures. Professor Franklin may be addressed during October and November at Columbia University, New York City.

AT the forty-third annual meeting of the American Public Health Association, held in Rochester, N. Y., September 6 to 10, under the presidency of Professor William T. Sedgwick, of the Massachusetts Institute of Technology, the following officers were elected: President, Dr. John F. Anderson, director of the hygienic laboratory of the United States Public Health Service, Washington, D. C.; first vice-president, Dr. George W. Goler, health officer of Rochester, N. Y.; second vice-president, Dr. Charles J. Hastings, medical officer of health, Toronto, Canada; third vice-president, Dr. Omar Gillette, of Colorado Springs, Colo.; treasurer, Dr. Lee K. Frankel, of New York (reelected); secretary, Professor Selskar M. Gunn, of Boston (reelected). The following were elected to honorary membership in the association: Surgeon-General William C. Gorgas, United States Army; Dr. Stephen Smith, of New York, a member of the State Board of Charities; Dr. Frederick Montizambert, of Ottawa, director general of public health of the Dominion of Canada; and Dr. Henry D. Holton, of Brattleboro, Vt.

PROFESSOR HENRY R. FRANCIS, of the Landscape Extension Service of the College of Forestry at Syracuse, is completing a field study of the 300-mile highway which is being planned by the Massachusetts Forestry Association and which will run from Boston westward nearly to the New York line and then turn back eastward to Cambridge.

NELSON C. BROWN, professor of forest utilization in the State College of Forestry at Syracuse, has returned from a 6,000-mile trip

through the National Forests of the Rockies and Cascades.

Dr. David Marine, of the H. K. Cushing Laboratory of Experimental Medicine, Western Reserve University, has returned from Compiégne, France.

Miss Mary C. Bliss, instructor in botany in Wellesley College, has been granted a year's leave of absence for graduate work at Radcliffe College.

Mr. H. M. Jennison, assistant professor of botany and bacteriology in Montana State College, will spend the year in research work in the Missouri Botanical Garden.

A memorial to the late Dr. Hugh Dewar was unveiled in the Abercorn Public Gardens, Portobello, Edinburgh, on September 5. It bears the following inscription: "This fountain has been erected in remembrance of Dr. Hugh Dewar, Portobello, by his grateful patients and numerous friends, who deplore the loss in the prime of manhood of a kind friend and skilful and beloved physician. His quiet charity was known to the needy. 1866–1914."

Dr. William Watson, from 1865 to 1873 professor of mechanical engineering and descriptive geometry in the Massachusetts Institute of Technology, since 1884 recording secretary of the American Academy of Arts and Sciences, has died in his eighty-second year.

Howard A. Nelson, a graduate student at the University of Minnesota, was drowned while engaged in work on the state and federal geological survey near Ely.

Professor Kunckel, docent for chemistry at Rostock, has died at the age of forty-seven years.

By the will of the late Dr. Dudley P. Allen, formerly professor of surgery in the Western Reserve University, $200,000 has been set aside as a permanent endowment fund for the Cleveland Medical Library.

The library of the University of Washington has acquired a complete set of the *Philosophical Magazine* from its establishment in 1798 at a cost of approximately $1,000.

The war is responsible for the disappearance of two medical papers, the *Allegemeine Wiener medizinische Zeitung*, established sixty years ago, and the *Prager medizinische Wochenschrift*, established forty years ago.

The awards granted to the Bausch & Lomb Optical Co., at the Panama-Pacific Exposition aggregate four "grand prix," or highest awards, one medal of honor and one gold medal. The award in each case was the highest prize granted. The four classes in which Bausch & Lomb Optical Co. received the "grand prix" are optical instruments, balopticons, engineering instruments and range finders. The first division, called optical instruments, covers seven classes and covers the company's ophthalmic lenses, microscopes, parabolic and Mangin mirrors, field glasses, microtomes and magnifiers. A medal of honor was awarded Bausch & Lomb photomicrographic apparatus; their photographic lenses received the gold medal.

The New York State College of Forestry at Syracuse has received a valuable gift of 120 mounted game and water birds, and 21 mounted mammals from Congressman Peter G. Gerry, and his brother, Robert L. Gerry, both of Providence, Rhode Island. This collection was secured for the college through the interest and help of Dr. William T. Hornaday, director of the Zoological Garden at Bronx Park. Dr. Charles C. Adams, forest zoologist of the college, had presented to Dr. Hornaday earlier the urgent need of the college for mounted birds and mammals. Soon after this Mr. Robert L. Gerry wrote to Dr. Hornaday about the disposal of the Gerry game collection, as it will be called by the college, and Dr. Hornaday recommended that the collection be turned over to it. Such a collection of mammals and birds is of very great value in training foresters, not only to enable them to know at sight the important game and water birds and forest mammals, but also as an aid to an appreciation of their relation to the forest. In some localities in the west the Federal Forest Service wardens are required also to be game wardens. The administrator of forest lands

needs not only to be intelligent on game if he is to execute the laws properly, but he needs furthermore to know the influence of game and fur-bearing animals upon forests.

Curator W. C. Mills, of the Ohio Archeological and Historical Society, and also of the Archeological Museum of the Ohio State University, has this summer been excavating a mound situated on the farm of State Senator W. D. Tremper. It has yielded hundreds of valuable specimens, which show remarkable skill in the art of graving and carving. In addition, there is evidence that here in this mound communal or tribal relations existed, for instead of numerous individual graves, one common grave served for the receptacle for hundreds of bodies. There are many other characteristics, which make this mound stand out. For instance, it was found that a wooden palisade had been erected around it. It was also discovered that the builders worked in quartz and several specimens were obtained. The Tremper mound is in form that of an animal enclosed by an embankment or wall. It is 250 feet long, with an average width of 50 feet and a maximum height of 8½ feet. Because of its resemblance to an animal it early became known as the Elephant Mound, although recent exploration has proved this formation to be incident to its use and construction and not intended to represent an animal.

Probably the most accurate method for the determination of the value of the strength of an electrical current in absolute measure is by means of the Rayleigh current balance, in which the current to be measured is passed in series through two parallel circular coils of unequal radii, one of which is suspended from the beam of a balance. The distance between the planes of the coils is varied until the force of attraction between the two coils is a maximum, and the value of the force is obtained by adding weights to the other arm of the balance until its equilibrium is restored. Since the maximum force obtainable depends on the ratio of the radii of the coils alone, and not on their individual dimensions, it is only necessary to determine further the ratio of the radii of the coils, and this may be done with great accuracy by electrical means. The constant of the instrument, that is, the maximum force per unit current for the coils in question, has been obtained in the past by interpolation between values of the force, calculated for various assumed distances of the coils, in the neighborhood of the critical value for which the force is a maximum. For, although the general formulas of Maxwell and Nagaoka give the value of the force for any two given coils, at any assumed distance with great accuracy, no formula has been heretofore published for calculating at what distance the force becomes a maximum. To supply this lack there is derived in a paper just published by the Bureau of Standards, Department of Commerce, entitled "The Calculation of the Maximum Force between Two Parallel, Coaxial, Circular Currents," a formula which gives the critical distance as a function of the ratio of the radii. The latter part of the paper is devoted to the development of methods for facilitating the calculations. The formulas are illustrated by numerical examples and tables, and the new formulas are shown to give results in agreement with those derived by more indirect and laborious method of interpolation. Copies of the publication, Scientific Paper No. 255, may be obtained on request of the Bureau of Standards, Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

A colonial mansion at 4037 Pine Street, Philadelphia, modeled after Washington's Mount Vernon home, has been purchased by the Mask and Wig Club, the University of Pennsylvania dramatic organization. After extensive alterations it will be turned over to the university as a gift to be used as the official residence of Pennsylvania provosts. The value of the gift exceeds $75,000.

Professor Charles A. Kofoid, professor of zoology, University of California, is on sabbatical leave for the current academic year. He is spending the first half of it in research work in Berkeley and will travel in the Orient

after January 1. Associate Professor S. J. Holmes has been granted leave of absence for the current academic year on account of ill health. Dr. R. Ruggles Gates, of the Missouri Botanical Garden, has been appointed acting associate professor in zoology for the current academic year, and Assistant Professor J. Frank Daniel has been made acting head of the department of zoology. Professor Robert C. Rhodes, professor of biology in Henderson Brown College, Arkadelphia, Arkansas, and Instructor Harry B. Yocum, of Kansas State Agricultural College, have been appointed assistants in zoology.

The new professional school of chemistry of the University of Pittsburgh began its work on September 27, under the deanship of Dr. Raymond Foss Bacon, director of the Mellon Institute of Industrial Research. A prescribed four-year undergraduate curriculum leads to the degree of bachelor of chemistry, and the staff of instruction includes the regular faculty of the university and fellows from the Mellon Institute of Industrial Research who are especially qualified in various theoretical and technical branches. This combination gives the new school the opportunity to offer not only the usual undergraduate and graduate courses in chemistry and technology, but also specialized work under men who are experts in specific American industries. In addition, thirty special lectures by prominent chemists and technologists in the Pittsburgh district, have been arranged for the academic year 1915–16. Attendance at these lectures is required of the student body and they are also open to the public. The professorate of the new school is constituted as follows: Alexander Silverman, M.S., professor of chemistry and head of the department of inorganic, analytical and physical chemistry; David S. Pratt, Ph.D., professor of chemistry and head of the department of organic, sanitary and micro-chemistry; Samuel R. Scholes, Ph.D., E. Ward Tillotson, Jr., Ph.D. and Edmund O. Rhodes, M.S., professors of applied chemistry; Benjamin T. Brooks, Ph.D., professor of chemical engineering; William A. Hamor, M.A., professor of chemistry; Henry A. Kohman, Ph.D. and Harold Hibbert, ScD., professors of applied organic chemistry; Leonard M. Liddle, Ph.D. and R. Phillips Rose, M.S., professors of organic chemistry; Lester A. Pratt, Ph.D., professor of inorganic chemistry, and C. C. Vogt, Ph.D., professor of physical chemistry. Thirteen assistant professors and ten instructors complete the teaching staff of the school.

At Lafayette College, Dr. Beverly W. Kunkel, of Beloit College, has been appointed head of the department of biology, and Dr. William Mackay Smith, of the University of Oregon, professor of mathematics.

Dr. Robert Chambers, Jr., assistant professor of histology and comparative anatomy in the medical department of the University of Cincinnati, has resigned to accept a position on the staff of Cornell Medical College.

Dr. Harold Kniest Faber (A.B., Harvard, 1906; M.D., University of Michigan, 1911), formerly connected with the Rockefeller Institute for Medical Research, New York City, has been appointed assistant professor of pediatrics at the Stanford University Medical School.

William Webb Kemp, a graduate of Stanford and Ph.D. of Columbia, now professor of education in the University of Montana, has been appointed professor of school administration in the University of California.

Dr. Maurice Parmelee is taking the place of Professor A. E. Jenks, chairman of the department of sociology and anthropology of the University of Minnesota, for the first semester of the present academic year.

Dr. Frank A. Hartman, of the department of physiology in the Harvard Medical School, has been appointed lecturer in physiology at the University of Toronto.

H. G. Plimmer, F.R.S., pathologist to the Zoological Society, has been appointed professor of comparative pathology in the Royal College of Science, London.

Professor Adolf Windaus, of Innsbruck, has succeeded Professor Otto Wallach as director of the chemical laboratory at Göttingen.

DISCUSSION AND CORRESPONDENCE

CONVENIENCE VERSUS FITNESS

In recent numbers of Science a series of articles[1] has appeared pleading for the conservation of the genus as known in the early days of biology, to the sacrifice of explicitness in nomenclatural recognition of the modern increase in morphological knowledge.

As clearly recognized by Sumner[2] this is a continuation of the plea of convenience in behalf of the *status quo* that has marked recent controversies over zoological and botanical nomenclature, and is voiced by and in behalf of the same classes of objectors—the general zoologist, the amateur, the college professor, and the "true nature lover." The case of the protestants has been quite fully and ably presented in the first paper of the series, and somewhat amplified and further illustrated by the other two contributors. To reply to their points seriatim is beyond the scope of the present article, but a few words may be offered from the other point of view, that of the berated "taxonomists."

In the opening article of the series it is said:

> But there is another perennial source of confusion which has not received adequate attention. Apparently it is regarded as quite unavoidable, or perhaps it is not commonly thought of as a difficulty of *nomenclature* at all. I refer to the continual changing of names that results from the subdivision of genera. . . . And if we look for the distinctions upon which these subdivisions are based, we commonly find that the differences are very trifling indeed in comparison with the many and detailed points of resemblance between these various groups.[3]

The same author further states:

> . . . it must be borne in mind that in the Linnæan system of binomial nomenclature the generic name plays two quite distinct rôles. One of these is to designate a taxonomic group, supposed to be intermediate between the family and the species. The other is *to form the first half of the "scientific" name of each species within that group.* It is for this reason that the changing of a generic name is so much more disconcerting than is changing that of the family or order. And this is why, in the writer's opinion [he describes himself in a preceding paragraph as "one who is not a taxonomist at all"], such splitting as we have just recognized to be inevitable should be done *within the limits of the genus,* either by the creation of "subgenera," or, if necessary, by the establishment of wholly new categories between the genus and the species.[4]

In other words, any method that will avert the direful interposition of a new generic name!

The second contributor to the discussion says:

> Few zoologists ever stop to think how far we are getting away from a real binomial system of nomenclature. It is true that scientific names of animals still consist of two words, but only in a minority of cases does the first term of the binomial have any real meaning to us, or suggest ideas of a much broader and more comprehensive character than the second one. The genus name has become little more than a prefix to, or part of, the species name. . . . We learn generic names, if we learn them at all, by mere acts of memory, and we use them because we find them in the latest monographs and might be thought not up to date if we did otherwise, but what the distinctions are between these multitudes of closely allied genera we rarely stop to enquire.[5]

Notwithstanding this naïve confession, the author admits the utility of such minor divisions if they are not permitted to affect nomenclature.

> They exist in nature and should have a recognition commensurate with their importance. . . . Classification has gained in exactness and truthful representation of the facts, but through our neglect to keep the first term of our scientific names comprehensive in its application, and easily distinguished and remembered in its meaning, we have allowed our nomenclature to lose most of the prac-

[1] Sumner, F. B., "Some Reasons for Saving the Genus," Science, N. S., XLI., No. 1068, pp. 899–902, June 18, 1915. Van Name, Willard G., "Losing the Advantages of the Binomial System of Nomenclature," Science, N. S., XLII., No. 1075, pp. 187–189, August 6, 1915. Colton, Harold S., "Another Reason for Saving the Genus," Science, N. S., XLII., No. 1079, pp. 307, 308, September 3, 1915.

[2] *L. c.*, p. 899.

[3] Sumner, *l. c.*, pp. 899, 900.

[4] *Ibid.*, p. 900.

[5] Van Name, *l. c.*, p. 187.

tical advantages and conveniences of the Linnæan system.[6]

The author of the third article cited above places great stress upon the fact that "It is by genera that animals and plants are catalogued," and considers that "this whole discussion hangs on the question, is it necessary to change generic names to advance our knowledge?" He goes on to reiterate:

In conclusion, generic names are those by which animals are catalogued, therefore should not be changed without overwhelming evidence in favor of the change. This value of the generic name has not been sufficiently emphasized.[7]

These three writers (for they all harp essentially on the same string) seem, despite all their admissions, really to forget that increase in knowledge leads in all fields of scientific progress to the introduction of new technics. It is not only necessary to learn new facts but new terms for their expression. In the good old days of the last half of the eighteenth century and the early part of the nineteenth, zoological genera were few; and when those founded by the great Linnæus proved, in the opinion of his immediate successors, to be inadequate to satisfactorily meet the requirements of their new discoveries, they proposed what were in fact new generic groups, but in deference to the past apologized for their seeming disrespect of the *status quo* and demurely called them subgenera, to break the shock of their seeming irreverence. Yet as years passed these groups gradually took their place in the systems as valid genera, and more were constantly added. The old Linnæan genus *Mus* included at first marmots and flying squirrels, as well as all the rat- and mouse-like animals then known. All known deer and antelope were each included in a single genus, and so on through many other groups.

More than one eighteenth century genus has since been distributed into several *families*, to say nothing of genera. And what an inconvenience this must have been for the "general zoologist" to have to learn so many new generic names! What a trouble it must have been too for the cataloguer! But such is the history of science, and who is to say when we have genera enough, and how many shall be weeded out as merely useless and confusing, and how many more may be conserved as subgenera, and thus save the present-day overworked "general zoologist" and his fellow sufferers from knowing that such divisions and names have ever been proposed by the poor specialists who were so misled in their researches as to think them necessary.

[6] *Ibid.*, p. 187.

[7] Colton, *l. c.*, p. 308.

I must confess, however, that I share the weaknesses of my class, the specialists, in believing that the primary function of nomenclature is to express the facts of classification, not to conceal them. The old genus *Sciurus*, in its early sense, comprised all squirrel-like animals of all parts of the world. In its old sense it would now comprise several hundred species, all looking near enough alike to be called squirrels, yet containing a score or more natural groups, sharply defined geographically and by minor but not unimportant morphological characters. Many of these minor groups are now currently given the rank of genera, others stand as merely sections or subgenera. Arranged thus in a monograph or in a systematic catalogue their various degrees of relationship and their interrelationships might be approximately expressed, but incidental references to them under the single generic name *Sciurus* places all on the same level, with no clue as to whether they are closely or remotely related, or to the kind of squirrel intended. If on the other hand they are mentioned under their modern group names the specialist knows, and the general zoologist should know, exactly their relationship to other squirrels, in other words, what kind of a squirrel is indicated. But this is apparently of no importance to advocates of "convenience" as the prime factor in every matter relating to nomenclature.

An intelligible compromise would be the use of both the generic name (in the broad sense) and the subgeneric name (in parenthesis) in incidental references. But this would be intolerable in the general zoologist, as it would, in the case of subspecies, involve in effect a quadrinomial nomenclature, and a further departure from the primitive binomial of the

good old times of thirty to fifty years ago when (to quote Van Name), "a genus name had in those days a real meaning to some others besides the specialists in the class of animals to which the genus happened to belong."[8]

It is of course to be admitted that there are good genera and bad genera; that many groups have been proposed as subgenera or even full genera on inadequate grounds. Our synonymies show what has been the fate of many of them, and a like fate doubtless awaits many, of recent origin, that have still to be weighed in the balance of concurrent approval. As the value of characters is a question that can not, from its nature, be made the subject of rules, as can questions of nomenclature, there seems only the slow relief afforded by time and the concurrent judgment of the specialists of each field for the evils of too much subdivision.

J. A. Allen
American Museum of Natural History,
New York

THE INHERITANCE OF CANCER

In a short note[1] I have recently commented on Dr. Maud Slye's work on the inheritance of cancer in mice. As to the credit due Dr. Slye for her careful and laborious experiments there can be no question. The importance of the subject, however, is such that it is essential to understand the exact distinction between the gathering of valuable data and the interpretation of such data when gathered.

The impression that Dr. Slye believed that cancer was inherited in a Mendelian fashion appears to have been more or less generally created by her paper already mentioned. Any one reading the editorial on her work in the *Journal of the American Medical Association* (Vol. 64, p. 1,326) can not fail to see that the "great laws" of heredity mentioned there are intended to be the Mendelian laws. The whole subject is treated from that standpoint and the optimism apparent must be considered to be chiefly due to the belief that Dr. Slye's work is an example of Mendelian inheritance.

So too, any one reading the review of recent work on cancer research by Dr. W. A. Dennis in the *St. Paul Medical Journal* (Vol. 17, pp. 494–500) can see that he believes that

> . . . the importance of her findings lies in the fact that hereditary transmission . . . is not fortuitous but that, given parents of pure breed the results of crossing may be confidently predicted.

After outlining correctly the basic principles of Mendelian inheritance, with the cross of albino and gray mice as an example, Dennis goes on to say:

> Maud Slye has taken advantage of this law [Mendel's] of heredity to study the transmissibility or inheritability of cancer in mice. . . . These studies [Slye's] have shown that the appearance and numerical value of the albino character can be predicted with certainty from the manner of mating the parents. The same is true of the whirling character of the Japanese waltzing mouse *and the same has been demonstrated to be true of cancer.*[2]

The fact that no correction of the impression so created was apparently forthcoming, and the fact that the diagrams in Slye's paper showing the inheritance of albinism represented a hitherto undescribed type of heredity led me to comment on her work.

Slye's recent denial of any desire or intention to apply a Mendelian interpretation to her experimental results is an extremely important postscript to her paper since it makes it virtually impossible to expect the exact numerical predictions in crosses which her reviewers have believed could be made.

Further than this, Slye's beliefs as to the inheritance of albinism are, as I have stated before, at sharp variance with the experimental results of Castle, Allen, Bateson, Durham, Cuénot, Plate, Davenport and others. The suggestion made by Slye[3] that the utilization of wild grays rather than "artificial laboratory" grays places her work in a position different from that of these other investigators is not significant, for I have repeatedly used wild grays in my crosses and have found that their hybrids obey Mendel's law in respect to the color characters which they inherit.

I have suggested that Dr. Slye's data show-

[8] *L. c.*, p. 187.

[1] Science, N. S., Vol. 42, pp. 218–219.

[2] *Italics mine.*

[3] Science, N. S., Vol. 42, pp. 246–248.

ing the non-Mendelian inheritance of albinism be published. To this she has replied that this data "in no way affects the transmission of cancer." I can only add that when one investigator suggests a revolutionary hypothesis which is contrary to the experimental results obtained by a large number of investigators in the same field, it is customary to present with the hypothesis the data on which it depends for its support.

Dr. Slye is right when she says in speaking of heredity,

> Exceptions to what was the canon have become so numerous as to be part of the rule.

One of the few points, however, on which all Mendelians, rabid or only semi-rabid, are agreed is that a homozygote forms one type of gamete in respect to the pair of factors for which it is homozygous. This is the principle which by diagrams and text Dr. Slye denies. Is it not fair to those who have not observed the type of inheritance mentioned by Slye to once more request the publication of the complete data on which this type of inheritance rests?

C. C. Little

Harvard Medical School,
September 7, 1915

THE HEREDITY OF STATURE

To the Editor of Science: The undersigned is making a study of the heredity of the elements of stature and desires the cooperation of those who are in a position to give it.

The first requirement is a household with both parents and at least two children above the age of 16 years; the more children above this age the better. If one or more grandparents, uncles and aunts are available they should be included in the study. The second requirement is a tape, if possible, 6 feet long, but a yard tape will do.

The procedure is to rule columns on ordinary writing paper, one column each for father, mother, each child and also each grandparent or uncle or aunt who may be available. The first horizontal line will be for sex; the second for age and the following four for the four measures. Then measure and record for each person: 1, total stature (without shoes); 2, sitting height; 3, height of top of fibula above sole of foot and, 4, vertical distance from vertex of head to depression at upper end of sternum (between the collar bones). The only suggestions are: (1) The stature may be taken standing against a door frame; the subject looking straight forward, a book is placed, binding downward, against the top of the head and square with the wall; mark the level of the book on the door frame and measure down to the floor. (2) Place the chair by the door frame; place subject sitting upright in chair, his back against door frame; indicate level of vertex in same fashion as in standing height and measure from mark to the level of the seat of the chair. (3) The top of the fibula is easily felt on *outside* of knee as a bony prominence from which a tendon runs to the thigh. (4) The head-and-neck measurement is to be strictly vertical. Place the 0 end of tape in the book; close the book so that the 0 mark is flush with the binding. The subject standing by wall, place book square against wall; then measure down along side of the nose to the sternum. All measurements should be recorded in ½ (or ¼) inches or in centimeters. Full names are desired for reference in case further correspondence is necessary but no names will be published.

It will be found interesting to preserve a copy of the record but please send one copy to me. If desired I will send ruled paper and a tape for the measurements.

C. B. Davenport

Station for Experimental Evolution,
Cold Spring Harbor, N. Y.

THE NATIONAL ACADEMY OF SCIENCES

In Science of July 30, Professor Richards has made public a letter addressed by him to the secretary of the National Academy. In this letter he volunteers advice to that learned body. He appears to think that it should cease to exist, because it covers too wide a field. Astronomers, biologists, chemists, physicists, zoologists, etc., should not be provided with any opportunity to mix even if they desire to do so. A man who has been giving his entire attention to the abdominal parasites of the white ant, should present his results to a society covering that ground only.

I have listened to papers presented to the Mathematical Society, which were wholly unintelligible to me, and I learned on inquiry on one occasion that two of the foremost mathematicians in the country, who were present, were equally in the dark. Such exhibits are often presented by men who are ambitious to say something, and who have nothing of any importance to say. It is difficult to give advice to them, it is a somewhat delicate matter, but they need advice. Many technical details which are not only proper, but necessary in a published paper, may be omitted in the oral presentation of that paper. Any person of ordinary good sense should know how to adapt an oral presentation to an audience.

There is a growing tendency among a certain class of scientific men, to lose all interest in everything outside of their own narrow horizons. This is much to be regretted. But such men have their remedy in their own hands. No one can object to the formation of physical or chemical societies, but it is to be hoped that we are not all so limited in our horizons that we shall advise academies of science to cease to exist.

FRANCIS E. NIPHER

A PROPOSED ECOLOGICAL SOCIETY

AT the Philadelphia meeting of the American Association for the Advancement of Science about twenty men interested in ecology met informally on the evening of December 30, 1914, to consider the advisability of organizing an American Ecological Society. The immediate occasion for the conference was an expression of feeling on the part of Professor R. H. Wolcott and Professor V. E. Shelford to the effect that there is now no adequate opportunity for plant and animal ecologists to meet together, and also that there is for ecologists an urgent need of summer field meetings in addition to the present winter meetings.

The conference was attended by Messrs. Adams, Bartlett, Blodgett, Bray, Cannon, Cowles, Dachnowski, Griggs, Harshberger, Hill, Jennings, MacDougal, Nichols, Pearse, Shantz, Shelford, Shreve, Taylor and Wolcott, Professor Harshberger being selected chairman. The opinion was practically unanimous that the time is ripe for the organization of an Ecological Society, and it was voted, in connection with the Columbus meeting of the American Association, to call a conference of all ecologists interested in the formation of such a society. A committee was appointed to call such a conference and present a scheme of organization, the committee consisting of Professor J. W. Harshberger (chairman), Professor V. E. Shelford (vice-chairman), Professor H. C. Cowles (secretary-treasurer), Professor R. H. Wolcott, Professor Charles C. Adams, Dr. Forrest Shreve.

Announcement will be made later of the exact time and place of the Columbus conference, but it may be assumed that it will not be earlier than Tuesday, December 28, nor later than Thursday, December 30, 1915. The purpose of this early announcement is to give ample opportunity for full expression of opinion. It is hoped that all working ecologists will write to the undersigned, noting (1) whether the proposed society is favored or disfavored and why, and (2) whether attendance at the Columbus conference is to be expected.

HENRY C. COWLES

UNIVERSITY OF CHICAGO

GREENE VARDIMAN BLACK

TO THE EDITOR OF SCIENCE: Will you permit me to call attention to the death of Dean Greene Vardiman Black? He was a figure of world-wide importance. Even before he was called to the deanship of Northwestern University Dental School he had established an international reputation as a man of science, and I think it fair to say that no man in his time—perhaps in any time—has done more to advance his profession.

He brought to his work a broad general and sound scientific training. He had the natural equipment of a man of science. It was his research work which developed and practically gave to the world the amalgam of to-day. He was the inventor of one of the first cord driven, foot power, dental engines. His scientific contributions number nearly one thousand.

He has been recognized by medical and scientific societies in this country and abroad. Five years ago he was given an appreciation banquet by the Chicago Odontographic Society. Among the delegates were many from distant places in the United States, and gifts were received from this and foreign countries.

In 1912, he was the recipient of the Miller prize of the International Dental Federation. Dr. Black was the first to receive this medal, and the award was made to him because of his researches and work in many branches of dental science. The medal was delivered personally by Floristan Aguilar, of Madrid.

At Northwestern, he found a school of moderate equipment which he built up until it acquired a world-wide reputation, and it has become in size one of the largest, if not the largest in the country. His former pupils are scattered over the world—in almost every civilized country—in America, in Europe, Asia, Africa and Australia. He is one of the outstanding great figures in professional education in this city.

His two great works are "Dental Anatomy" and "Operative Dentistry," which are standards in dental schools of to-day.

A. W. Harris

Northwestern University

SCIENTIFIC BOOKS

Selected Papers. Surgical and Scientific, from the writings of Roswell Park, late Professor of Surgery in the University of Buffalo and Surgeon-in-Chief to the Buffalo General Hospital. With a memoir by Charles C. Stockton, M.D. Published by the Courier Company, Buffalo, N. Y. 1914. Pp. 381.

No finer memorial could exist for Roswell Park, surgeon, scientist, litterateur, historian and educator, than this book of papers selected from the huge list of writings, the bibliography of which shows the extent of his surgical interests.

These selected papers, including one of Dr. Park's earliest, as well as the very latest paper prepared by him, portray vividly how during his thirty-six most active years his surgical and scientific interests developed and expanded. Especially does one wonder at the amount of work accomplished during the last five years of his life as shown by the output of no less than twenty-one important papers, each of which bears evidence of active laboratory research and hours of library study.

Many of these papers are distinctly technical in character, but whether discussing the intricate details of a difficult surgical technic or the results of laboratory researches, Dr. Park never loses sight of the ultimate aim of surgical technic and laboratory findings—their humanitarian significance.

One is particularly impressed with the keen intellect, which, in the midst of large surgical activities and the stress of ill-health, could study and digest such scientific details, along other than his own special lines of research, as are included in the references listed after the paper "Of What Does the Universe Consist?" His interest in radioactivity, however, is but one of the many instances in which he made an absorbing study of some new physical or chemical discovery, that he might discern its widest clinical application.

One must read between the lines of these papers the important part played by Dr. Park himself in the researches which he discusses. Another writer of the history of carcinoma, for example, would carry his account to a later date and would not fail to speak of Dr. Park as the prime mover in the establishment of the Gratwick Laboratory, now the New York State Laboratory and Hospital for the study of Malignant Diseases. So also in writing of "The Present Status of Antiseptic Surgery" and the "Primary Antiseptic Occlusion and Treatment of Gunshot Wounds," another writer would speak with enthusiasm of Dr. Park's early acceptance of the principle of antisepsis, and of his studies of infections, which were the prime reason for his appointment to deliver the Mütter Lectures on Surgical Pathology at Philadelphia in 1892.

The brief biography by Dr. Charles T. Stockton is satisfying in its delineation of those periods and experiences in Dr. Park's life which contributed most to make him the man whom his fellow citizens, his pupils, his

surgical colleagues and fellow scientists knew, admired and loved. G. W. Crile

Cleveland, Ohio

Societal Evolution: A Study of the Evolutionary Basis of the Science of Society. By Albert Galloway Keller, professor of the Science of Society in Yale University. New York, The Macmillan Co., 1915. Pp. 330. $1.50.

Some years ago when he was professor of political and social science in Yale University, William Graham Sumner introduced the term "societal" into sociological terminology. His purpose was to employ a word more definite than "social" in order to emphasize the distinctively collective or group activities of individuals. "Social," he thought, had too many meanings to be exact. Following this usage, Sumner included in his remarkable book, "Folkways," an interesting chapter on what he termed "societal selection." In most concrete fashion did he therein show how by group or "societal" action, various "folkways" and "mores," as he termed them (*i. e.*, customs), whose origin is often obscure, are more or less consciously and intelligently chosen or "selected" by the group, become authoritative and finally compel conformity.

Professor Keller, modestly characterizing the present volume "as an extension of Sumner's work," employs "societal" in his title and in the main accepts Sumner's conceptions as a basis for his own contributions. The extension consists essentially in an endeavor to show both that there is "societal" evolution and that the manner in which such evolution occurs can advantageously be stated in terms employed by Charles Darwin in the biological field. To use Professor Keller's own language: "The question I have asked myself is: can the evolutionary theory, according to Darwin and his followers . . ., be carried over into the social domain without losing all or much of the significance it possesses as applied in the field of natural science?" He expressly denies that the eugenists in their attempts to prove the effectiveness of natural selection in human society have really attacked this general issue. Professor Keller considers that natural selection is a term which in a very literal sense can and ought to be applied in the theory of social evolution not only with a strictly biological meaning, but also with a social, or, shall we say, "societal" meaning? He finds "a something in the social field which *is* variation, whether or not it may be like what is called variation in the organic field; similarly, social selection *is* selection and not merely *like* it." This "something" appears to be the differences among those customs which Sumner called folkways and mores. In conformity with this conception there are chapters on "variation," "automatic and rational selection," "counter selection," "transmission" and "adaptation." In these chapters occur many interesting instances of transformations in customs interpreted as illustrations of the processes just named.

The author vigorously defends his application of these Darwinian terms to social phenomena. "I shall be charged, doubtless," he says, "'with reasoning from analogy,' but I do not feel that the charge is deserved." To the present reviewer, however, there is a question raised by the use Professor Keller makes of these terms and the manner in which he deals with certain parts of his material, far more important than a possible "reasoning by analogy" of which he seems apprehensive. "Reasoning by analogy" is perfectly legitimate if thereby the reasoner develops a hypothesis that is capable of independent proof. Thus the known refrangibility of light and heat, Spencer tells us, produced the inquiry as to whether sound is not also refrangible. On investigation this proved to be the case. The analogy led to discovery. If in the present instance valuable discoveries had resulted from a use of an analogy, no one could have objected. Such, however, does not appear to be the fact. Many, if not practically all, of the important actual social processes emphasized by Professor Keller have been clearly discussed at one time or another by various sociological writers without unnecessary resort to biological phraseology. Even Walter Bagehot in "Physics and Politics," which he subtitled

"Thoughts on the Application of the Principles of 'Natural Selection' and 'Inheritance' to Political Society" did not particularly stress the importance of the biological terms he at times employed. Although in one passage Bagehot refers to natural selection among animals and in human history as "identical in essence," he nevertheless in the very next paragraph remarks concerning his use of the term: "At all events to the sort of application here made of it [*i. e.*, in 'Physics and Politics'], which only amounts to searching out and following up an analogy suggested by it, there is plainly no objection." Bagehot points out, as does Keller, the fact that differences in customs affect the efficiency of rival groups and may thereby indirectly affect the chances of survival possessed by their observers. Bagehot went on, as does Keller also, to treat in a very broad way the relation of custom, of unconscious imitation, of reason and of many other factors to the survival and progress of groups and nations. Bagehot did this, however, without at all falling into the confusion necessarily produced by ignoring or rather obliterating by a *tour de force* the plain distinction between natural selection in the strict Darwinian sense and the same term loosely used for natural conscious or unconscious social choices. Transference of biological terms into the sociological field and use of them in the literal fashion employed by Professor Keller does not offend so seriously in "reasoning by analogy" as it does in what seems to the reviewer a misleading and scientifically illegitimate use of precise biological terms. There is no need to repeat in a somewhat different form the sort of thing which followed Spencer's application of the term organism to society.

The foregoing criticism, however, is very largely one of terminology and the careful reader will find much of great value in Professor Keller's book. The differences among customs, the ways in which various customs have originated, the effects of conscious and unconscious imitation, the relation of suggestion, of conflict and of reason to the development of specific customs—these and other special subjects are presented and illustrated in an interesting fashion.

A. A. TENNEY

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

THE ninth number of Volume 1 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *The Indian and Nature:* ALICE C. FLETCHER, Peabody Museum, Harvard University.

Glimpses are given of the line the Indian pursues in his endeavor to express his view of nature and of the relation he believes to exist between its various forms and forces and himself.

2. *The Mechanism of Antagonistic Salt Action:* JACQUES LOEB, Rockefeller Institute for Medical Research, New York.

The author studies the effect of the concentration C_{III} of the salt at the external surface of membranes in addition to the concentrations C_I and C_{II} of the salt outside and inside the membrane and finds that C_{III} is serviceable in explaining the mechanism of antagonistic salt action in certain cases.

3. *The Nitrogen Problem in Arid Soils:* CHAS. B. LIPMAN, College of Agriculture, University of California.

A summary of some recent investigations and field manifestations with reference to their bearing on problems of soil fertility in California.

4. *A Notation for Use in the Discussion of Star Colors:* FREDERICK H. SEARES, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

The extension of absolute scales of photographic and photovisual magnitudes to the fainter stars provides a method of determining the colors of objects at present beyond the reach of spectroscopic investigation and it is convenient in the statistical discussion of such color results to introduce a notation similar to that used for spectral classification. The letters *b*, *a*, *f*, *g*, etc., are used to correspond to *B*, *A*, *F*, *G*, etc.

5. *Distribution of Colors among the Stars of N. G. C. 1647 and M. 67:* FREDERICK H. SEARES and HARLOW SHAPLEY, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Neither N. G. C. 1647 nor M 67 show any dependence of condensation upon color which can not be explained on the basis of included background stars; there seems to be little, if any, dependence of condensation upon magnitude; but there is a marked relation between color and magnitude in N. G. C. 1647 and a less pronounced relation in M 67.

6. *On Thiele's "Phase" in Band Spectra:* HORACE SCUDDER UHLER, Sloane Physical Laboratory, Yale University.

The author outlines an interpolation method for determining c in the formula $\lambda = f[(n+c)^2]$, which is much simpler than using Thiele's complicated formula.

7. *Why Polar Bodies Do Not Develop:* EDWIN G. CONKLIN, Department of Biology, Princeton University.

The second or internal factor in normal fertilization is a non-diffusible substance which is introduced by the spermatozoon, and it is strongly suggested that this factor is the sperm centrosome, a position which Boveri has long maintained and which the author has hitherto contested. Giant polar bodies do not develop because they are not fertilized and they are not fertilized because they are generally formed after a spermatozoon has entered the egg and has rendered it impervious to other spermatozoa.

8. *Radical Velocities of the Planetary and Irregular Nebulæ:* W. W. CAMPBELL and J. H. MOORE, Lick Observatory, University of California.

The fact that the gaseous nebulæ have motions which are characteristic of the stars, and their concentration in the Milky Way, indicate that these nebulæ are members of our stellar system. The great velocities of the nebulæ in the Magellanic Clouds and other considerations lead to the hypothesis that the Magellanic Clouds are isolated cosmic units with no apparent connection with our own stellar system.

E. B. WILSON

SOME CORRELATIONS BETWEEN VEGETATION AND SOILS, INDICATED BY CENSUS STATISTICS

ALTHOUGH most persons who have lived or traveled extensively in the rural districts of the eastern United States have probably noticed that the proportion of evergreens in the forests is usually greatest on the poorest soils, and *vice versa*, one rarely sees any mention of such a correlation in scientific, especially ecological, literature. Most plant ecologists who have taken notice of evergreens at all seem to try to correlate them with climate in some way; but the easily demonstrated fact that two areas so close together or so similarly situated that they must have essentially the same climate often differ greatly in their percentage of evergreens shows that climate is not the only factor.[1]

The making of definite correlations between evergreens (or other aspects of vegetation) and soils has always been difficult on account of the dearth of quantitative data. No reliable quantitative analysis of the vegetation of a whole state has yet been made, and it would take many years to do such a piece of work thoroughly. To estimate the average composition, either physical or chemical, of the soils of an area of more than a few square miles would be even more difficult, for no matter how many samples were collected and analyzed, the judgment of the persons selecting them would always introduce a "personal equation" factor, unless the samples were selected wholly fortuitously, or at regular intervals (for example, at the corners or centers of every section of land).

Our knowledge of the chemical composition of the soils of the United States is still far from satisfactory. In Bulletins 57 and 85 of the U. S. Bureau of Soils are summed up most of the available chemical analyses, by states, and for some states there are only two or three, and those probably not typical; and they are not all made by the same methods. In fact soil investigators are not yet agreed on what method gives the best indication of

[1] In this connection see Torreya 13: 244. 1913, *Rep. Mich. Acad. Sci.*, 15: 196–197, 1914; *Ann. Rep. Fla. Geol. Surv.*, 6: 175, 393–396, 1914.

productivity, or correlates best with the native vegetation.

In the reports of the Census Bureau there are statistics, made so thoroughly as to practically eliminate the personal equation, that throw valuable light on both evergreen percentages and soil fertility. The percentage of evergreens is one of the most conspicuous and easily determined features of vegetation that can be expressed numerically, and it is almost the only one (and certainly the most significant one) that can be calculated from existing census statistics.

In 1911 the U. S. Census Bureau and Forest Service jointly published an octavo bulletin (without a number) entitled "Forest Products of the United States, 1909," giving among other things the output of lumber, laths and shingles by the sawmills of the United States in the year named, by states and by species simultaneously. Similar statistics have been published for subsequent years, but those for 1909, which were gathered in connection with the regular decennial census, seem to be the most complete.

Other things being equal, the lumber sawn from deciduous and evergreen trees in a given area should be proportional to the percentage of those trees in the forests; but other things are not equal. In the first place, it is of course the percentage of evergreens in the primeval forests that counts, and as the deciduous trees prefer the richer soils, a larger proportion of them than of the evergreens have been destroyed by farmers in clearing land for cultivation. Second, the evergreens in the United States are mostly (counting individuals, not species) conifers, and conifers on account of their gregarious habit and straight-grained easily worked wood are more sought after by lumbermen than the hardwoods are.

In the census statistics of lumber production all the hardwood trees listed are deciduous. (Some evergreen hardwoods are cut in the southeastern states, but in insignificant quantities.) The figures for evergreens are therefore obtained by subtracting from the total for conifers those for the two deciduous genera, *Taxodium* and *Larix* (cypress and tamarack). To make allowance for the hardwoods that have been destroyed by farmers, and the neglect of the remaining ones by lumbermen, the figures for them (not for all deciduous trees) are arbitrarily multiplied by 4. This product added to the figures for conifers and divided into the total evergreens (not total conifers) gives a percentage which is believed to approximate pretty closely in most cases the percentage of evergreens in the original forests.

Some idea of the fertility of the soil in different parts of the country can be obtained from several different sets of figures in the census reports. In rural districts there is a close relation between soil fertility and density of population; but in the northeastern states so large a population is supported by manufacturing, independently of the subjacent soil, that statistics of population there would be of very little use in this connection. Figures showing the value of land are open to the same objection.

The census gives the acreage of "improved land" in the farms of each state and county, and that is undoubtedly correlated with soil fertility, whether the fertility is due to physical or chemical conditions or something else; and the tendency to utilize the land more fully in the neighborhood of cities is partly offset by the occupation of much land for other purposes than farming, and such land is not included under "improved land in farms." For the purposes of this investigation the statistics of improved land have been taken from the Tenth Census (1880), because earlier censuses are probably less complete, and because the use of commercial fertilizers has increased so much since then as to tend to obliterate differences in productivity between different kinds of soil.[2]

Another kind of statistics given for each state and county in recent census reports is the

[2] In the South some sandy soils which were regarded as almost worthless half a century ago are valued more highly at the present time than the rich clayey or calcareous soils, because they are more easily tilled, and yield large returns for the amounts invested in fertilizers.

expenditure for fertilizers for the year preceding that in which the census was taken. The ratio between that and the total acreage of improved land is certainly a function of the natural fertility of the soil, although it is of course governed by some other factors as well.[8] If we determine the relative fertility of different states or counties by striking an average between the results obtained from a study of the percentage of improved land and the amount of fertilizer used per acre perhaps we shall not be far wrong; and still greater accuracy might be obtained by using additional criteria of an analogous nature.

The present study is limited to the eastern half of the United States; because in the West farming is chiefly confined to areas originally treeless, and there is no necessary connection between the fertility of such areas and the composition of the forests in the same states, which may occupy very different soils. Massachusetts, Rhode Island and Connecticut are omitted because their large urban population, deriving most of its food from the farms of other states, complicates matters too much; New Jersey for a similar reason and also because its most abundant evergreen, *Pinus rigida*, is of little value for lumber and therefore does not figure very largely in the returns; and Illinois, Iowa and Minnesota for the same reason as the western states.

In the table below the 24 remaining states are arranged in the order of their evergreen percentages, as determined in the manner above described, with the highest first. The first column of figures contains these percentages, the second the percentage of the total area "improved" in 1880, and the third the amount spent for fertilizer in 1909 for each acre of improved land reported in April, 1910. The last column gives the average rank of the states as determined by columns 2 and 3. *E. g.*, Florida ranks first in proportion of unimproved land, and second in the use of fertilizer per acre, making its average rank 1½.

States	Per Cent. of Evergreens	Improved Land 1880	Fertilizer per Acre 1909–10	Average Rank
Florida	91.5	2.7	$2.00	1½
South Carolina	80.0	21.2	2.49	4½
Georgia	77.4	21.8	1.37	7
New Hampshire	72.2	40.0	.55	13
Alabama	68.2	19.5	.79	7
Maine	68.0	18.3	1.72	4
Louisiana	65.6	9.4	.38	7½
Mississippi	55.3	17.6	.30	9½
North Carolina	51.5	20.8	1.39	5½
Delaware	41.5	59.4	1.21	14
Virginia	36.1	33.0	.70	11½
Vermont	35.9	56.3	.35	17
Wisconsin	34.6	25.9	.01	18
Arkansas	30.3	10.7	.07	12
New York	26.8	58.1	.48	17½
Pennsylvania	24.2	46.8	.54	14½
Michigan	19.8	22.6	.07	16
Maryland	19.0	52.0	1.01	13
West Virginia	13.5	24.7	.10	15
Missouri	6.9	38.1	.03	19
Tennessee	4.7	31.9	.11	15½
Kentucky	2.3	41.8	.09	18½
Ohio	0.5	69.3	.22	20
Indiana	0.1	60.6	.13	20

The departure of the last column from a numerical sequence indicates how far the evergreen percentages and soil fertility, *as determined from census statistics*, from which the personal equation is practically eliminated, fail to correspond. The average difference between these figures and what they should be if the correlation were perfect is only 2⅝, whereas if there were no correlation at all the probable average difference would be two or three times as great. The correspondence is as close as could reasonably be expected under the circumstances; and moreover, some of the discrepancies are easily explained.

For example, in Maryland, North Carolina and Tennessee a large proportion of the deciduous forest is in mountainous regions, too rough for farming but not for lumbering, so that the true evergreen percentages are probably higher than the figures indicate. In Mississippi and Louisiana the deciduous trees are mostly in swamps, which also repel farmers more than lumbermen. In New Hampshire, Vermont, New York and Wisconsin conditions

[8] Some persons with whom the writer has discussed the matter during the past year pretend to believe that the amount of fertilizer used depends mainly on the enterprise of the farmers, but they would hardly contend that the farmers of South Carolina and Florida are ten times as enterprising as those of Ohio and Indiana!

are somewhat reversed, the evergreens being *mostly in places unattractive to farmers*, and the apparent percentages of them probably too high. The percentage of improved land in West Virginia and Arkansas is rather low, perhaps chiefly because these states are off the main routes of travel and have not received as many settlers as their soil would warrant. It is low in Mississippi and Louisiana on account of large areas of alluvial land, which although very rich (and originally wooded almost exclusively with deciduous trees) were very little cultivated in 1880 on account of being subject to overflow. In the northern states improved land includes a large proportion of pasture, on which no fertilizer is used, and if the amount of cultivated land could be substituted for improved land the fertilizer figures for these states would average considerably more per acre.

Finally, it can not be doubted that different chemical elements in the soil affect evergreen percentages and other features of vegetation unequally, and it is well known that the composition of rich soils varies greatly in different states. The soils of Florida are generally well supplied with calcium and phosphorus, but deficient in potassium, while in Illinois phosphorus is said to be the element most in danger of exhaustion. The average composition of fertilizers used varies from state to state, corresponding more or less with the soils (a larger proportion of potassium is used in Florida than in any other state), but no statistics of fertilizer ingredients are given in census reports; so that matter will not be taken up at the present time.

Roland M. Harper

SPECIAL ARTICLES

STANDARD DAIRY SCORE CARDS

Mr. James D. Drew[1] presents data which should be of very general interest. The purpose of this note is to direct attention to these studies in the hope that they may receive the wide attention which they deserve. The most important result of such consideration would be the carrying out of even more comprehensive and exact studies of the same kind.

The problems taken up are essentially two:

a. What is the correlation between the grades assigned a series of dairies by the same inspectors when different score cards are used?

b. What is the correlation between the score assigned a dairy by an inspector and the quality of the milk which it places upon the market?

The first of these problems is of technical importance in determining the degree of reliability of the application of score cards to the grading of dairies. The second is fundamental to the determination of the utility of the score card in the grading of milk, and thus one of first rate practical significance to the consumer of dairy products.

For purposes of review it has seemed best to express the detailed observations in the succinct terms of statistical constants. The personal opinion of the reviewer that such statistical constants are better as a means of expressing the results than the mere comparison of individual points of detail, and his conviction that the analysis of the data in certain of its more refined essentials can be carried out only by such formulæ, must not be taken as a criticism of the data or their discussion in the paper under review.

With regard to the agreement between the three methods of grading, the authors confine their discussion to the relative positions of the individual dairies on the three score cards. The correlation coefficients[2] are illuminating. They are:

[1] Drew, J. D., "Milk Quality as Determined by Present Dairy Score Cards," *Bull. N. Y. Agr. Exp. Sta.*, 398, Geneva, March, 1915. The work was originally planned by Dr. H. A. Harding, and is now being carried out in cooperation with the Illinois Agricultural Experiment Station.

[2] Data for 34 barns are given. For 23 of these bacterial counts for morning milk as well as evening milk are available. As a precaution against arithmetical slips I have marked out the correlations between the results by the three cards for both the total series and the sub-series for which morning milk was available. The latter should be essentially a random sample of the former.

Card Used	$N=34$	$N=23$
New York City and Official score	.770 ± .047	.713 ± .069
New York City and Cornell score	.719 ± .056	.803 ± .050
Official score and Cornell score	.831 ± .036	.769 ± .057

These results for total score by the three different cards are high, but they fall far short of the $r=1$ which indicates perfect correlation, and which should be obtained if (*a*) the score cards were perfect descriptions of the barns as places for milk production, and if (*b*) the inspectors had perfect judgment in the filling out of the cards. It is interesting to note that the grades assigned by the three methods agree equally closely (within the limits of the probable errors of sampling) whatever cards are used: New York City and Official, New York City and Cornell, and Official and Cornell gradings have sensibly the same correlation.

In the case of the New York City and the Official score, methods are graded separately. The correlations are

For 34 barns, $r=.480 \pm .089$
For 23 barns, $r=.412 \pm .117$

Thus the correlation for methods are but slightly over half the size of those for total score. This suggests that the 40 points awarded for equipment in both the New York City and the United States Department of Agriculture ("Official") cards is the great factor in bringing about a close agreement in the results (total score) obtained by the two methods. Correlating points assigned for equipment only (total score *minus* score for methods) I find

For 34 barns, $r=.733 \pm .054$
For 23 barns, $r=.685 \pm .075$

The lower correlation of the values assigned for methods as compared with those for equipment is perhaps the most serious criticism to be made of the score cards.

While the agreement between the scores assigned by different cards falls far short of perfect correlation, it is interesting to note that *the agreement is actually closer than that for bacterial count in evening and morning milk from the same dairies.* Here the correlation is only

$$r=.456 \pm .111.$$

The relationships between the scores assigned by the various cards and the bacterial counts are naturally the results of the greatest interest. All the possible correlations have been worked out and are presented in the accompanying table.

CORRELATION OF BACTERIAL COUNT WITH SCORE-CARD ENTRIES

Card Used	Evening Milk, 34 Barns	Morning Milk, 23 Barns
New York City		
Total score ...	− .077 ± .115	− .046 ± .140
Methods only..	+ .024 ± .116	− .061 ± .140
Equipment only	− .170 ± .113	− .022 ± .141
Official		
Total score ...	− .003 ± .116	− .196 ± .135
Methods only.	− .140 ± .113	− .310 ± .127
Equipment only	+ .065 ± .116	− .039 ± .141
Cornell	− .013 ± .116	− .102 ± .139

Twelve out of 14 of these correlations are negative in sign. All six of those for total score are negative. In other words, as the ratings assigned by the inspectors became higher the bacteria became fewer. This is of course as one would like it to be. Practically, however, the author's statement, that there is apparently no correlation between the bacterial count and score as expressed by any one of the cards, fully expresses the facts. The constants are almost without exception very small indeed. There is not a single one which can be safely considered as significant in comparison with its probable error!

Such are the results:

a. The correlation between the total scores assigned the same barns by the same inspector using the three most important cards is only about three quarters of its theoretical maximum value. The correlation between the scores for methods only is less than half its theoretical value.

b. There is practically no correlation at all between the scores assigned the barns by dairy inspectors and the bacterial content of the milk which they place upon the market.

c. When correlations so low as those deduced from the present figures are found between the bacterial counts of morning and evening

samples of milk from the same barns, it is clear that much remains to be done in the perfection of the technique of sampling and bacteriological analyses of milk.

These data show how flimsy is the basis for the common belief that there is a relation between the score of a dairy and the quality of the milk produced by it, and how premature the official sanction for the grading of milk by means of dairy scores.

J. Arthur Harris

"SOIL ACIDITY AND METHODS FOR ITS DETECTION"[1]

In a previous issue of Science, J. E. Harris[2] published an article entitled similarly as above. In this article Harris states that two theories have been advanced to explain soil acidity, viz., the humic-acid theory and the colloid absorption theory. This same investigator also makes reference to an article published by the present writer on a new method for the determination of soil acidity,[3] and after quoting the writer in regard to the use of calcium chloride in this method, says:

> This statement brings out very clearly the absurdity of the position of those who accept the humic acid theory. These humic acids are supposed to be strong enough and soluble enough to liberate hydrochloric acid from calcium chloride, but not strong enough or soluble enough to liberate hydrogen sulphide from zinc sulphide. It is also suggested that this method be made the basis for a quantitative determination of the lime requirements of the soil. The writer does not believe this is possible because he has shown[4] that acid soils do not absorb equivalent amounts of different ions.

Although Harris apparently assumes that the writer believes soil acidity in upland soils is due largely to the so-called humic acids, yet the writer has never published such views or believed that such was the case. The writer also wishes to state that he is even more adverse to accepting the colloid absorption theory as an explanation of soil acidity, than he is to accepting the so-called humic acid theory. The acidity of peat and muck soils is undoubtedly due in part to organic acids. There are upland soils, however, which are practically free of organic matter and still they react strongly acid. Similar soils containing considerable organic matter appear to retain all their acid properties even after the organic matter is destroyed with hydrogen peroxide. What is this inorganic acidity due to? Harris and many other investigators have assumed that it is due to absorption of bases by soil colloids. They have arrived at this conclusion because by their methods of experimentation, acid soils do not take up chemically equivalent amounts of the different bases. Colloids exhibit similar properties as to the absorption of bases, and hence they conclude that soil acidity is due to colloids. Let us carefully examine the facts and draw our conclusions accordingly:

Upland soils consist of from 75 per cent. to over 95 per cent. of silicates and silica. Silicates are salts of various silicic and aluminosilicic acids. The water solution in the soil slowly reacts with these silicates, forming with the bases of the silicate a soluble hydroxide or salt, which is taken up by plants or removed in the drainage water. The other product, an acid silicate, being comparatively insoluble, accumulates in the soil and gives rise to an acid condition. The writer and assistants have treated powdered basalt, granite, feldspar and other minerals with carbonated water, and after filtering have obtained residues which are acid to litmus and other tests. This is essentially comparable to the weathering process going on in soils. Acid soils treated in this way are made more acid.

If soil acidity is due to true acids and acid salts such as acid silicates, why have investigators not been able to show that acid soils take up equivalent amounts of the different bases from salt solutions? This is due to the fact that the acid silicates and their neutralized products are only very slightly soluble, and the solubility of the neutralized silicates varies according to the base that effects the neutralization. The law on which the ad-

[1] Published with the permission of the director of the Wis. Expt. Station.

[2] Science, 40 (1914), 49.

[3] Science, 40 (1914), 246.

[4] *Jour. Phy. Chem.*, 18 (1914), 355.

herents of the colloid theory base their conclusion reads as follows: The relative affinity of the acids is independent of the nature of the base. *It must be carefully noted that this law only holds when all the reacting substances are in a true solution, or if there are partially soluble substances formed, then in any series of comparisons, the solubility of the corresponding substances must be of the same order. The opportunity for secondary or side reactions must also be eliminated or made comparable. In the soil there is almost unlimited opportunity for these side reactions to occur. Most previous investigators of soil acidity and absorption have entirely overlooked and ignored these most important considerations and hence have accordingly arrived at erroneous conclusions.*

In order to overcome these difficulties and make the conditions more comparable, the writer has proceeded as follows: Small amounts of very finely powdered soil were thoroughly shaken with comparatively large amounts of the respective salt solutions for a short period and then quickly filtered, and the acidity of the filtrate determined. *When this was done the soil took up very nearly equivalent amounts of different bases from salts having a common acid ion.* The use of very finely powdered soil and the procedure of thoroughly shaking made the conditions more like those of a true solution than was the case of other investigators. The use of an overwhelming mass of salt solution in comparison to the soil used equalizes the side reactions to a large extent. The main reaction takes place almost instantly, and hence the treatment should be short in order to prevent further side reactions. The results of these experiments point strongly to the existence of true acid substances as the cause of soil acidity.

Besides this active acidity, there is in soils usually a considerable amount of inactive acidity, which comes into play on continued treatment with salt solutions or basic materials. The writer has evidence, though not conclusive, which indicates that kaolin is a substance which may exist as either an active or an inactive acid. It is possible that rearrangements of the molecule, or polymerization may be the cause of this. In contact with basic material, kaolin gradually takes up more and more base, which may be due to the gradual change of kaolin to the active acidic form. Treatment with carbon dioxide or other acids also seems to cause a change to the active form.

The writer and assistants have perfected a new quantitative method for soil acidity. In this method 25 g. of soil are moistened in a casserole with 35 c.c. of water and then treated with an excess of barium hydroxide solution. This is allowed to act for *one minute* with constant stirring and then carbon dioxide is immediately passed in, changing the excess of hydroxide to the carbonate. The material is evaporated to complete dryness on a steam bath, and then the excess of hydroxide is measured by determining the carbonates present. A special form of apparatus has been devised for making this carbonate determination. It can also be used for determining carbonates in non-acid soils. When the determination is made by this method, it makes little difference whether calcium, barium or sodium hydroxide is used to neutralize the acidity. If soil acidity is due to colloids, then according to the properties of colloids it should take different chemical equivalent amounts of sodium, barium and calcium hydroxide. This, again, indicates very strongly that soil acidity is due to true acids and not colloids. The writer has a considerable amount of other data which bears on the subject at various angles, but always supports the existence of true acids as the cause of soil acidity.

There is no question but what colloids exist in soils. Some colloids absorb bases and others absorb the acid ion. The amount of absorption, however, in the case of the pure colloids which have been worked with in the laboratory is very small in comparison to the phenomena going on in acid soils. The absorption capacity of these colloids is practically negligible as far as soil acidity is concerned. The wrongly so-called selective absorption of bases in soils has received a large amount of attention during the past fifty years, but the ex-

planations of the phenomena have never been satisfactory. It is for the most part not an absorption phenomenon but a true chemical reaction consisting of an exchange of bases between a soluble salt and silicate, or else a neutralization of acid substances by the base of a salt giving rise to a soluble acid, as in the case in acid soils. In the case of peats and soils high in organic matter, organic compounds may cause similar phenomena. The writer has been unable to obtain or find any data which on careful consideration would lend support to the colloid absorption theory of soil acidity.

The new test for soil acidity which the writer had previously described[5] has now been tried on a very large number of soils and found entirely satisfactory. As is obvious, it is absolutely necessary to use *neutral* calcium chloride and zinc sulphide in the test. Merck's reagents have given perfect satisfaction. In reply to Harris,[6] the writer wishes to state that acid soils react without the use of calcium chloride and hence his comment does not apply.

Although soils are composed for the most part of silica and silicates, yet the function of the silicates in soil fertility has been almost entirely ignored. Their function in the inorganic world is analogous to that of the proteins and carbohydrates in the organic world. The complex nature and behavior of the silicates makes possible the great regulatory processes going on in soils. The property of certain silicates by means of which they change from an active acidic state, a condition in which they actively take up bases from solution, to a condition of inactivity, and also the change in the reverse direction, is of the greatest importance. This property makes possible the presence of an enormous amount of such silicates which prevent undue loss by leaching without giving rise to the excessively acid condition which would otherwise be necessary. The root hairs of plants are probably among the most delicate of all external organs in either plant or animal life. In the soil there are a great variety of processes going on, resulting undoubtedly in the formation of not only beneficial substances, but also of some harmful ones. If this is the case, it is probable that nature has made some provision for inhibiting the deleterious action of the harmful substances on the delicate root hairs. It seems possible that the silicates may form temporary combinations with these substances and thus prevent unfavorable action on the root hairs. The wonderful influences, in other than physical ways, of a small amount of such silicates commonly called clay, on the fertility of sandy soils has been known for a long time, and a consideration of the above aids greatly in its explanation. The writer has in preparation a detailed paper dealing with the subject of soil acidity and related phenomena.

E. Truog

Department of Soils,
Wisconsin Experiment Station,
University of Wisconsin

[5] *Loc. cit.*

[6] *Loc. cit.*

A NEW METHOD OF MEASURING THE CONCENTRATION OF THE SOIL SOLUTION AROUND THE SOIL PARTICLES

In conducting a thorough investigation on the general subject of soil temperature the influence of soluble salts on the lowering of freezing point of soils was also studied. It was observed that the phenomena of supercooling and freezing behaved in moist soils exactly the same way as in solutions. These facts suggested the ideas that the freezing point method might be employed to measure the concentration of the soil solution around the soil particles. In order to ascertain whether or not this could possibly be done a series of experiments was instituted, using different classes of soil with various moisture contents, or known concentration of solutions. It has been found that the freezing point of the soil solution around the soil particles can be determined with great ease. Solidification can be started when the soil mass is supercooled to only about 0.2° C., by simply moving the thermometer in the soil. The starting of the solidification is far easier in soils than in solutions. The freezing point of soils can be determined even when the moisture con-

tent is reduced to or slightly below the wilting coefficient. In the case of quartz sand, for instance, the freezing point can be measured when the amount of water present is only about 0.8 per cent. Below the wilting coefficient the solidification is started with some difficulty, and the duplicate determinations do not agree very closely, especially if the concentration of the solution is very high. Above the wilting point the solidification does not only start with great ease, but the determinations can be duplicated with a surprising closeness; the values either agree exactly with one another or show deviations of only a few thousandths of a degree, using the Beckmann thermometer.

In determining the freezing point of different classes of soil the remarkable fact was discovered that the freezing point lowering, and consequently the concentration of the soil solution varies directly with the amount of water present. The following figures show the freezing point lowering, using distilled water as a basis of comparison, of natural soils containing high and rather low moisture content.

TABLE I

Freezing Point Lowering of Different Classes of Soil at Different Moisture Content

Soil	Freezing-point Lowering	Per Cent. Moisture
Sand	0.033° C.	6.22
Loam	0.050	33.46
Clay	0.098	24.68
Clay	0.090	38.00
Peat	0.021	181.60
Sand	0.171	2.80
Loam	0.251	25.15
Clay	0.695	18.23
Clay	2.290	12.00
Peat	0.050	138.97

It will be evident from the above table that when the soils contain a high moisture content the lowering of the freezing point, and consequently the concentration, is rather small, and does not vary greatly between the different soils. But when the moisture content of these same soils is reduced considerably, the lowering of the freezing point is increased in some cases very greatly. When it is considered that about 4,000 parts of mineral salts in 1,000,000 of water cause a depression of the freezing point of only about 0.090° C., the above figures for the soils with low moisture content represent an enormous concentration, especially in some cases.

In order to ascertain (1) the sensitiveness of the method to detect differences in concentration in the soil solution, and (2) to see whether the concentration of the soil solution can be increased by the addition of mineral salts, a complete nutrient stock solution was prepared from which solutions were made up varying in concentration from 80 to 4,000 parts per million. The freezing point of these solutions alone, and in contact with soils was determined. Some of the results thus obtained are shown in Table II.

TABLE II

Lowering of the Freezing Point of Soils with a Nutrient Solution of Different Concentration

Lowering of the Freezing Point

	80 P. P. M.	2,000 P. P. M.	4,000 P. P. M.
Solution	**0.005**	**0.043**	**0.083**
Sand	0.005	0.040	0.085
Loam	0.005	0.036	0.067
Clay	0.006	0.037	0.065
Peat	0.005	0.021	0.050

The values for the soils represent the depression of the freezing point caused only by the addition of the respective solutions; the depression due to the soils themselves has been deducted.

An examination of the above results reveals the interesting fact that the lowering of the freezing point of the solutions in contact with the soils does not vary very much from that of the solution alone.

There is at present no other method capable of measuring the concentration of the soil solution in the soil or around the soil particles. The foregoing method has yielded, thus far, some very remarkable results, and promises to give us a better understanding of the fundamental principles governing the soil solution.

GEORGE BOUYOUCOS,
M. M. McCOOL
MICHIGAN AGRICULTURAL COLLEGE

SCIENCE

FRIDAY, OCTOBER 15, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PHYSIOLOGICAL IMPORTANCE OF PHASE BOUNDARIES[1]

EVEN a hasty consideration of the arrangements present in living cells is sufficient to bring conviction that the physical and chemical systems concerned operate under conditions very different from those of reactions taking place between substances in true solution. We become aware of the fact that there are numerous constituents of the cell which do not mix with one another. In other words, the cell system is one of many "phases," to use the expression introduced by Willard Gibbs.

Further, parts of this system which appear homogeneous under the ordinary microscope are shown by the ultra-microscope to be themselves heterogeneous. These are in what is known as the colloidal state. Some dispute has taken place as to whether this state is properly to be called a heterogeneous one, but it is sufficient for our purpose to note that investigation shows that the interfaces of contact between the components of such systems are the seat of the various forms of energy which we meet with in the case of systems obviously consisting of phases which can be separated mechanically, so that considerations applying to coarsely heterogeneous systems apply also to colloidal systems. Although the phases of a colloidal system can not be so obviously and easily separated as those of an ordinary heterogeneous one, this can be done almost completely by filtration through membranes such as the gelatin in

[1] Address of the President of the Section of Physiology at the Manchester Meeting of the British Association for the Advancement of Science.

Martin's process. To avoid confusion, however, it has been suggested that the colloidal state should be spoken of as "microheterogeneous." There are, in fact, certain phenomena more or less peculiar to the colloidal state and due to the influence of the sharp curvature of the surfaces of the minutely subdivided phase. The effect of this curvature is a considerable pressure in the interior of the phase, owing to the surface tension, and it adds further complexity to the properties manifested by it.

We see, then, that the chemical reactions of chief importance to us as physiologists are those known as "heterogeneous." This class of reactions, until comparatively recent times, has been somewhat neglected by the pure chemist.

In some of its aspects, the problem before us was discussed by one of my predecessors, Professor Hopkins, as also by Professor Macallum, but its importance will, I think, warrant my asking your indulgence for a further brief discussion. Permit me first to apologize for what may seem to some of those present to be an unnecessarily elementary treatment of certain points.

It is easy to realize that the molecules which are situated at the interface where two phases are in contact are subject to forces differing from those to which the molecules in the interior of either phase are subject. Consider one phase only, the molecules at its surface are exposed on the one side to the influence of similar molecules; on the other side, they are exposed to the influence of molecules of a nature chemically unlike their own or in a different physical state of aggregation. The result of such asymmetric forces is that the phase boundary is the seat of various forms of energy not present in the interior of the phase. The most obvious of these is the surface energy due to the state of tension existing where a liquid or a gas forms one of the phases. It would lead us too far to discuss the mode of origin of this surface tension, except to call to mind that it is due to the attractive force of the molecules for one another, a force which is left partially unbalanced at the surface, so that the molecules here are pulled inwards. The tension is, of course, only the intensity factor of the surface energy, the capacity factor being the area of the surface. We see at once that any influence which alters the area of the surface alters also the magnitude of that form of energy of which we are speaking.

This is not the only way in which the properties of substances are changed at phase boundaries. The compressibility of a solvent, such as water, are altered, so that the solubilities of various substances in it are not the same as in the interior of the liquid phase. It is stated by J. J. Thomson that potassium sulphate is 60 per cent. more soluble in the surface film. The ways in which the properties of a solvent are changed are sometimes spoken of as "lyotropic," and they play an important part in the behavior of colloids. We meet also with the presence of electrical charges, of positive or negative sign. These are due, as a rule, to electrolytic dissociation of the surface of one phase, in which the one ion, owing to its insolubility, remains fixed at the surface, while the opposite ion, although soluble, can not wander away further than permitted by electrostatic attraction. Thus we have a Helmholtz double layer produced.

Before we pass on to consider how these phenomena intervene in physiological processes, there is one fact that should be referred to on account of its significance in connection with the contractile force of muscle. Surface tension is found to *decrease* as the temperature rises, or, as it is sometimes put, it has a negative tempera-

ture coefficient. This is unusual; but, if we remember that the interface between a liquid and its vapor disappears when the temperature rises to the critical point, and with it, of course, all phenomena at the boundary surface, the fact is not surprising that there is a diminution of these phenomena as the critical temperature is approached.

Perhaps that result of surface energy known as "adsorption" is the one in which the conditions present at phase boundaries make themselves most frequently obvious. Since the name has been used somewhat loosely, it is a matter of some consequence to have clear ideas of what is meant when it is made use of. Unless it is used to describe a definite fact, it can only be mischievous to the progress of science.

Permit me, then, first to remind you of that fact of universal experience, known as the "dissipation of energy," which is involved in the second law of energetics. Free energy—that is, energy which can be used for the performance of useful work—is invariably found to diminish, if the conditions are such that this is possible. If we have, therefore, a system in which, by any change of distribution of the constituents, free energy can be decreased, such a change of distribution will take place. This is one form of the well-known "Principle of Carnot and Clausius."

Now, practically any substance dissolved in water lowers the surface tension present at the interface between the liquid and another solid or liquid phase with which it is in contact. Moreover, up to a certain limit, the magnitude of this effect is in proportion to the concentration of the solute. Therefore, as was first pointed out by Willard Gibbs, concentration of a solute at an interface has the effect of reducing free energy and will therefore occur. This is adsorption. As an example, we may take the deposition of a dyestuff on the surface of charcoal, from which it can be removed again, unaltered, by appropriate means, such as extraction with alcohol. Charcoal plus dye may, if any satisfaction is derived from the statement, be called a compound. But, since its chemical composition depends on the concentration of the solution in which it was formed, it is much more accurate to qualify the statement by calling it an "adsorption-compound." Moreover, the suggestion that the union is a chemical one tends to deprive the conception of chemical combination of its characteristic quality, namely, the change of properties. Dye-stuff and charcoal are chemically unchanged by adsorption.

The origin of adsorption from surface tension is easily able to explain why it is less as the temperature rises, as we find experimentally. As we have just seen, surface tension diminishes with increase of temperature.

Let us next consider what will happen if the liquid phase contains in solution a substance which lowers surface tension and is also capable of entering into chemical reaction with the material of which the other, solid, phase consists. For example, a solution of caproic acid in contact with particles of aluminium hydroxide. On the surface of the solid, the concentration of the acid will be increased by adsorption, and, in consequence, the rate of the reaction with it will be raised, according to the law of mass action. Further, suppose that the liquid phase contains two substances which react slowly with each other, but not with the solid phase. They will be brought into intimate contact with each other on the surface of the solid phase, their concentration raised and the rate of their interaction increased. One of the reagents may clearly be the solvent itself. But in all these cases the rate of the reaction can not

be expressed by a simple application of the law of mass action, since the active masses are not functions of the molecular concentrations, but of the surface of the phase boundaries. The application of these considerations to the problem of the action of enzymes and of heterogeneous catalysis in general will be apparent. That the action of enzymes is exerted by their surfaces is shown, apart from the fact that they are in colloidal solution, by the results of experiments made in liquids in which the enzymes themselves are insoluble in the usual sense, so that they can be filtered off by ordinary filter paper and the filtrate found to be free from enzyme. Notwithstanding this insolubility, enzymes are still active in these liquids. The statement has been found, up to the present, to apply to lipase, emulsin and urease, probably to trypsin, and the only difficulty in extending it to all enzymes is that of finding a substrate soluble in some liquid in which the enzyme itself is not. That adsorption is a controlling factor in the velocity of enzyme action has been advocated by myself for some years, but it is not to be understood as implying that the whole action of enzymes is an "adsorption phenomenon," whatever may be the meaning of this statement. The rate at which the chemical reaction proceeds is controlled by the mass of the reagents concentrated on the surface of the enzyme phase at any given moment, but the temperature coefficient will, of course, be that of a chemical reaction.

The thought naturally suggests itself, may not the adsorption of the reacting substances on the surface of the enzyme suffice in itself to bring about the equilibrium at a greater rate, so that the assumption of a secondary chemical combination of a chemical nature between enzyme and substrate may be superfluous? I should hesitate somewhat to propose this hypothesis for serious consideration were it not that it was given by Faraday as the explanation of one of the most familiar cases of heterogeneous catalysis, namely, the union of oxygen and hydrogen gases by means of the surfaces of platinum and other substances. The insight shown by Faraday into the nature of the phenomena with which he was concerned is well known and has often caused astonishment. Now, this case of oxygen and hydrogen gases is clearly one of those called "catalytic" by Berzelius. The fact that the agent responsible for the effect did not itself suffer change was clear to Faraday. I would also, in parenthesis, direct attention to the fact that he correctly recognized the gold solutions which he prepared as suspensions of metallic particles—that is, as what we now call colloidal solutions. Although the systematic investigation of colloids, and the name itself, were due to Graham, some of the credit of the discovery should be given to the man who first saw what was their nature. Adsorption, again, was accurately described by Faraday, but without giving it a name.

I confess that there are, at present, difficulties in the way of accepting concentration by adsorption as a complete explanation of the catalytic activities of enzymes. It is not obvious, for example, why the same enzyme should not be able to hydrolyze both maltose and saccharose, as it is usually expressed. Another difficulty is that it is necessary to assume that the relative concentration of the components of the chemical system must be the same on the surface of the enzyme as it is in the body of the solution; in other words, the adsorption of each must be the same function of its concentration. Unless this were so, the equilibrium position on the enzyme surfaces, and therefore in the body of the solution, would be a different one under the action of an enzyme from that arrived at spontaneously

or brought about by a homogeneous catalyst such as acid. This consideration was brought to my notice by Professor Hopkins, and requires experimental investigation. We know, indeed, that in some cases there is such a difference in the position of the equilibrium position, for which various explanations have been suggested. But it would be a matter of some interest to know whether this difference has any relation to different degrees of adsorption of the components of the system.

At the same time, adsorption is under the control of so many factors, surface tension, electrical charge, and so on, that the possibilities seem innumerable. There are, moreover, two considerations to which I may be allowed to direct your attention. Hardy has pointed out that it is probable that the increased rate of reaction at the interface between phases may be due, not merely to increased concentration as such, but that in the act of concentration itself molecular forces may be brought into play which result in a rise in chemical potential of the reacting substances. In the second place, Barger has shown that the adsorption of iodine by certain organic compounds is clearly related to the chemical composition of the surfaces of these substances, but that this relationship does not result in chemical combination or in abolition of the essential nature of the process as an adsorption. It would appear that those properties of the surface, such as electric charge and so on, which control the degree of adsorption, are dependent on the chemical nature of the surface. This dependence need not cause us any surprise, since the physical properties of a substance, inclusive of surface tension, are so closely related to its chemical composition.

There is one practical conclusion to be derived from the facts already known with regard to enzymes. This is, that any simple application of the law of mass action can not lead to a correct mathematical expression for the rate of reaction, although attempts of this kind have been made, as by Van Slyke. The rate must be proportional to the amount of substrate adsorbed, and this, again, is a function both of the concentration of the substrate and of that of the products. It is, then, a continuously varying quantity. Expressed mathematically, the differential equation for the velocity must be something of this kind:

$$\frac{dC}{dt} = KC^n$$

where n itself is an unknown function of C, the concentration of the substrate or products.

The hypothesis of control by adsorption gives a simple explanation of the exponential ratio between the concentration of the enzyme and its activity, which is found to be different numerically according to the stage of the reaction. At the beginning, it may be nearly unity; in the middle it is more nearly 0.5, as in the so-called "square root law" of Schütz and Borissov, which is, however, merely an approximation. Simple explanations are also given of the fact that increasing the concentration of the substrate above a certain value no longer causes an increased rate of reaction. This is clearly because the active surface is saturated. Again, the effect of antiseptics and other substances which, by their great surface activity, obtain possession of the enzyme surfaces, and thereby exclude to a greater or less degree the adsorption of the substrate, receives a reasonable account. In many cases, the depressant or favoring action of electrolytes, including acid and alkali, is probably due to aggregation or dispersion of the colloidal particles of the enzyme, with decrease or increase of their total surface. It is to be noted that such

explanations are independent of any possible formation of an intermediate compound between enzyme and substrate, *after* adsorption has taken place.

There is a further way in which adsorption plays a part in the chemical processes of cells, including those under the influence of catalysts. It is a familiar fact that the concentration of water plays a large part in the position of equilibrium attained in reversible reactions of hydrolysis and synthesis. A synthetic process is brought about by diminution of the effective concentration of water. There are, doubtless, means of doing this in the elaborate mechanisms of cell life, and, in all probability, it is by adsorption on surfaces, which are able to change their "affinity" for water.

I pass on to consider briefly some other cases in which the phenomena at phase boundaries require attention.

Let us turn our gaze from the interior of the cell to the outer surface, at which it is in contact with the surrounding medium. From the nature of adsorption there can be no doubt that, if the cell or the surrounding liquid contains substances which decrease surface energy of any form, these constituents will be concentrated at the interface. There are many such substances to be found in cells, some of lipoid nature, some proteins, and so on. Further, the experiments of Ramsden have shown that a large number of substances are deposited in surface films in a more or less rigid or solidified form. We are thus led to inquire whether these phenomena do not account for the existence of the cell membrane, about which so much discussion has taken place. We find experimentally that there are facts which show that this membrane, under ordinary resting conditions, is impermeable to most crystalloids, including inorganic salts, acids and bases. There is no other explanation of the fact that the salts present in cells are not only in different concentration inside from that outside, but that there may be absence of certain salts from one which are present in the other, as, for example, sodium in the plasma of the rabbit not in the corpuscles. Moreover, the experiments of Hoeber have shown that electrolytes are free in the cells, so that they are not prevented from diffusion by being fixed in any way. The mere assumption of a membrane impermeable to colloids only will not account for the facts, since, as I have shown in another place, this would only explain differences of concentration, but not of composition. The surface concentration of cell constituents readily accounts for the changes of permeability occurring in functional activity, since it depends on the nature of the cell protoplasm, and chemical changes of many and various kinds occur in this system. If such be the nature of the cell membrane, it is evident that we are not justified in expecting to find it composed of lipoid or of protein alone. It must have a very complex composition, varying with the physiological state of the cell. Indeed, complex artificial membranes have been prepared having properties very similar to that of the cell.

This view that the membrane is formed by surface condensation of constituents of the cell readily accounts for the changes of permeability occurring in functional activity, since its composition depends on that of the cell protoplasm, and chemical changes of various kinds take place in this system, as it is scarcely necessary to remind you. In fact, the cell membrane is not to be regarded as an independent entity, but as a working partner, as it were, in the business of the life of the cell. In the state of excitation, for example, there is satisfactory evidence that the cell membrane loses its character of semipermeability to electrolytes, etc. This statement has been shown

to apply to muscle, nerve, gland cells, and the excitable tissues of plants, as well as to unicellular organisms. We shall see presently how this fact gives a simple explanation of the electrical changes associated with the state of activity.

If, then, the cell membrane is a part of the cell system as a whole, it is not surprising to find that substances can affect profoundly, although reversibly, the activities of the cell, even when they are unable to pass beyond the outer surface. The state of dynamic equilibrium between the cell membrane and the rest of the cell system is naturally affected by such means, since the changes in the one component involve compensating ones in the other. Interesting examples of such actions are numerous. I may mention the effect of calcium ions on the heart muscle, the effect of sodium hydroxide on oxidation in the eggs of the sea-urchin, and that of acids on the contraction of the jelly-fish. Somewhat puzzling are those cases in which drugs, such as pilocarpine and muscarine, act only during their passage through the membrane and lose their effect when their concentration has become equal inside and outside the cell.

The work of Dale on anaphylaxis leads him to the conclusion that the phenomena shown by sensitized plain muscle can most reasonably be explained by colloidal interaction on the surface of the fibers. The result of this is increased permeability and excitation resulting therefrom.

I referred previously to the electrical change in excitable tissues and its relation to the cell membrane. It was, I believe, first pointed out by Ostwald and confirmed by many subsequent investigators, that in order that a membrane may be impermeable to a salt it is not a necessary condition that it shall be impermeable to both the ions into which this salt is electrolytically dissociated. If impermeable to one only of these ions, the other, diffusible, ion can not pass out beyond the point at which the osmotic pressure due to its kinetic energy balances the electrostatic attraction of the oppositely charged ion, which is imprisoned. There is a Helmholtz double layer formed at the membrane, the outside having a charge of the sign of the diffusible ions, the inside that of the other ions. Now, suppose that we lead off from two places on the surface of a cell having a membrane with such properties to some instrument capable of detecting differences of electrical potential. It will be clear that we shall obtain no indication of the presence of the electrical charge, because the two points are equipotential, and we can not get at the interior of the cell without destroying its structure. But if excitation means increased permeability, the double layer will disappear at an excited spot owing to indiscriminate mixing of both kinds of ions, and we are then practically leading off from the interior of the cell, that is, from the internal component of the double layer, while the unexcited spot is still led off from the outer component. The two contacts are no longer equipotential. Since we find experimentally that a point at rest is electrically positive to an excited one, the outer component must be positive, or the membrane is permeable to certain cations, impermeable to the corresponding anions. Any action on the cell such as would make the membrane permeable, injury, certain chemical agents, and so on, would have the same effect as the state of excitation. If we may assume the possibility of degrees of permeability, the state of inhibition might be produced by *decrease* of permeability of the membrane of a cell, which was previously in a state of excitation owing to some influence inherent in the cell itself or coming from the outside. This manner of account-

ing for the electromotive changes in cells is practically the same as that given by Bernstein.

It will be found of interest to apply to secretory cells the facts to which I have directed your attention. If we suppose that the setting into play of such cells is associated with the production of some osmotically active substance, together with abolition of the state of semi-permeability of the membrane covering the ends of the cells in relation with the lumen of the alveolus of the gland, it is plain that water would be taken up from the lymph spaces and capillaries and escape to the duct, carrying with it the secretory products of the cells. This process would be continuous so long as osmotically active substances were formed. Such a process has been shown by Lepeshkin to occur in plants, and we have also evidence of increased permeability during secretory activity in the gland cells of animals. From what has been said previously, it is evident that electrical differences would show themselves between the permeable and semipermeable ends of such cells, as has been found to be the case.

As a modifiable structure, we see the importance of such a membrane as that described if it takes part in the formation of the synapse between neurones. The manifold possibilities of allowing passage to states of excitation or inhibition and of being affected by drugs will be obvious without further elaboration on my part.

Enough has already been said, I think, to show the innumerable ways in which phenomena at phase boundaries intervene in physiological events. Indeed, there are very few of these, if any, in which some component or other is not controlled by the action of surfaces of contact. But there is one especially important case to which I may be allowed to devote a few words in conclusion. I refer to the contractile process of muscle. It has become clear, chiefly through the work of Fletcher, Hopkins and A. V. Hill, that what is usually called muscular contraction consists of two parts. Starting from the resting muscle, we find that it must have a store of potential energy, since we can make it do work when stimulated. After being used in this way, the store must be replenished, since energy can not be obtained from nothing. This restoration process is effected by an independent oxidation reaction, in which carbohydrate is burnt up with the setting free of energy which is made use of to restore the muscle to its original state. Confining our attention for the moment to the initial, contractile, stage, the essential fact is the production of a certain amount of energy of tension, which can either be used for the performance of external work or be allowed to become degraded to heat in the muscle itself. It was Blix who first propounded the view that the amount of this energy of tension is related to the magnitude of certain surfaces in the muscle fibers. But the fact was demonstrated in a systematic and quantitative manner by A. V. Hill. He showed, in fact, that the amount of energy set free in the contractile process is directly related to the length of muscle fibers during the development of the state of tension. In other words, the process is a surface phenomenon, not one of volume, and is directly proportional to the area of certain surfaces arranged longitudinally in the muscle. This same relationship has been shown by Patterson and Starling to hold for the ventricular contraction of the mammalian heart and by Kosawa for that of the cold-blooded vertebrate. It appears that all the phenomena connected with the output of blood by the heart can be satisfactorily explained by the hypothesis that the energy of the contraction is regulated by the *length* of the ventricular fibers during the period

of development of the contractile stress. The degree of filling at the moment of contraction is thus the determining factor.

That surface tension itself may be responsible for the energy given off in muscular contraction was first suggested by Fitzgerald in 1878, and it seems, from calculations made, that changes at the contact surface of the fibrillæ with the sarcoplasm may be capable of affording a sufficient amount. The difficulties in deciding the question are great, but, in addition to the facts mentioned, there is other interesting evidence at hand. It has been shown, by Gad and Heymans, by Bernstein and others, that the contractile stress produced by a stimulus has a negative temperature coefficient. Within the limits of temperature between which the muscle can be regarded as normal, this stress is the greater the lower the temperature. The same statement was shown by Weizsäcker (working with A. V. Hill) to hold for the heat developed in the contractile stage. Now, of all the forms of energy possibly concerned, that associated with phase boundaries is the only one with a negative temperature coefficient. Another aspect of this relation to temperature is the well-known increase of the tonus of smooth muscle with fall in temperature.

It is tempting to bring into relation with the change in surface tension the production of lactic acid. In fact, this idea was put into a definite statement by Haber and Klemensievich in 1909 in a frequently quoted paper on the forces present at phase boundaries. The production of acid is stated to alter the electrical forces at this situation. This electrical charge involves a change of surface tension, and it is this change of surface tension which brings about the mechanical deformation of the muscle. Mines also has brought forward good evidence that the production of lactic acid is responsible for the change of tension. As to how the lactic acid is set free, and of what nature the system of high potential present in muscle may be, we require much more information. The absence of evolution of carbon dioxide when oxygen is not present shows that no oxidation takes place in the development of tension. There are other difficulties also in supposing that this system present in resting muscle is of a chemical nature. If the energy afforded by the oxidation of carbohydrate in the recovery stage is utilized for the formation of another chemical system with high energy content, the theory of coupled reactions indicates that there must be some component common to both systems. It is difficult to see what component of the muscle system could satisfy the conditions required. On the whole, some kind of system of a more physical nature seems the most probable. If it be correct that the oxidation of substances other than carbohydrate, fat, for example, can afford the chemical energy for muscular contraction, as appears from the results of metabolism experiments, a further difficulty arises in respect to a coupled reaction. But the question still awaits investigation.

On the whole, I think that we may conclude that more study of the phenomena at phase boundaries will throw light on many problems still obscure. It would probably not be going too far to say that the peculiarities of the phenomena called "vital" are due to the fact that they are manifestations of interchange of energy between the phases of heterogeneous systems. It was Clerk Maxwell who compared the transactions of the material universe to mercantile operations in which so much credit is transferred from one place to another, energy being the representative of credit. There are many indications that it is just in this process of change of energy from one form

to another that special degrees of activity are to be observed. Such, for example, are the electrical phenomena seen in the oxidation of phosphorus or benzaldehyde, and it appears that, in the photo-chemical system of the green plant, radiant energy is caught on the way, as it were, to its degradation to heat, and utilized for chemical work. In a somewhat similar way, it might be said that money in the process of transfer is more readily diverted, although perhaps not always to such good purpose as in the chloroplast. Again, just as in commerce money that is unemployed is of no value, so it is in physiology. Life is incessant change or transfer of energy, and a system in statical equilibrium is dead.

W. M. BAYLISS

UNIVERSITY COLLEGE,
LONDON

THE PUBLICATION OF THE RESULTS OF INVESTIGATIONS MADE IN EXPERIMENT STATIONS IN TECHNICAL SCIENTIFIC JOURNALS[1]

IN order to gain a proper perspective for a consideration of the topic which has been assigned the final place in this discussion of experiment station publications, namely, the publication of results in scientific journals, including the *Journal of Agricultural Research,* it will be necessary to consider very briefly certain historical aspects of the question. Until within the last few years it has been a well-nigh universal practise of the experiment stations in this country to publish all, or very nearly all, of the material which they have had for publication in the form of bulletins. The reason for this practise, which has always seemed anomalous to scientific workers in other than agricultural fields, is of course found in the historical beginnings of station work and station publication in America.

Section 1 of the Hatch Act provides "That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation of agricultural science," experiment stations were to be established. Further on Section 4 provided "That bulletins or reports of progress shall be published" as often as once in three months, and these distributed to farmers and newspapers.

Now the idea plainly embodied in all this was that the station should issue bulletins in order that the farmers might be informed of the nature and results of its activities. This entirely laudable idea worked well enough at first. Very presently, however, as the character and quality of the station work changed and the stations began in some measure to fulfil the second purpose for which they were organized, namely, to contribute to agricultural knowledge by investigation, it came about that bulletins were sometimes issued which, from the very nature of the case, left the farmer, who had the temerity to tackle reading them, on the whole rather worse informed when he had finished than he was before he began. Something of this sort was bound to be the case as soon as experiment station work was of anything but the most superficial character. Just as soon as there began to be issued in bulletin form really scientific papers, of a technical character, it became evident that the publishing activity of a station must perform two separate and distinct functions, and not merely a single one as was evidently contemplated by those who prepared the Hatch Act.

These two functions are: (1) To inform the general public of the activity of the station, with reference to such matters as it (the public) is actually interested in from the viewpoint of practical farming. In other words, one function of station publication is, in the language of the original act, to diffuse among the people useful and practical information. (2) The second function of station publication is

[1] From the Maine Agricultural Experiment Station. This paper formed a part of a symposium on the various forms of station publication at the California meeting of the Association of American Agricultural Colleges and Experiment Stations in the Station Section. The paper was read by Director Charles D. Woods, in the absence of the author.

to promote the progress of agricultural science and stimulate further investigation by making available to workers in that branch of science complete and detailed technical accounts of what has already been done. Technical scientific publication is absolutely necessary to the advance of science. The reason why scientific men publish their results is *not*, as some executives sometimes appear to believe, in order that they may get better jobs, but to contribute their mite to the accumulated and classified experience of the world, which is science.

The distinction between these two reasons for publication was almost entirely lost sight of in the earlier history of the stations. One regrets to observe that even in the present enlightened era of experiment station evolution there does not appear to be universally present a clear and complete discrimination between these two different, and indeed essentially antithetic, sorts of publication. Not very long ago one of our most distinguished directors, in a praiseworthy desire to assert the equality (or even superiority) in respect of intellectual attainment of his constituency as compared with the constituencies of other stations, made a statement in a scientific journal to the broad effect that his institution never had and probably never would put out anything not easily within the comprehension of the worthy and enlightened farmers of his state. Leaving aside as not quite relevant here the fact that such a statement carries *two* implications, one of which I fancy its genial author overlooked in his zeal to make the other, it would seem clear that such a position does not do full justice to the purely scientific function of a part of any station's publications.

The general thesis which I should like to make the text of this paper is that while what has been called above the first function of station publishing activity, namely, the diffusing among the people of useful knowledge, is, on the whole, well served by the bulletin form; on the other hand, the second or purely scientific function of station publishing is, on the whole, badly served by that form. Further, the attempt will be made to show that the best manner of serving the second function, which the whole experience of the world's scientific workers has brought forth, is by publication in established scientific journals.

As a first step towards the establishment of this thesis it is desired to quote a short extract from a most entertaining and famous treatise published nearly four hundred years ago. This work is "A Boke, or Counseill against the Disease Commonly Called the Sweate, or Sweatyng Sicknesse made by Jhon Caius, Doctour in Phisicke. Uery necessary for euerye personne, and muche requisite to be had in the handes of al sortes, for their better instruction, preparacion and defence, against the soubdein comyng, and fearful assaultyng of the same disease. 1552."

John Cajus, or, in its English form Kaye, it will be recalled, was the man who brought about the elevation to the rank of a college of Gonville Hall at Cambridge, since known as Gonville and Cajus College. He was one of the most distinguished physicians of his day, and withal an exceedingly keen, witty and shrewd person, whose great learning never upset his common-sense. In his introduction to the "Sweatyng Sicknesse" he mentions his earliest writings, which were translations out of Latin into English. He goes on to say:

> Sense y^t tyme diuerse other thynges I haue written, but with entente neuer more to write in the Englishe tongue, partly because the comoditie of that which is so written, passeth not the compasse of Englande, but remaineth enclosed within the seas, and partly because I thought that labours so taken should be halfe loste among them whiche sette not by learnyng. Thirdly for that I thought it beste to auoide the judgment of the multitude, from whome in maters of learnyng a man shalbe forced to dissente, in disprouyng that whiche they most approue, & approuyng that whiche they moste disalowe. Fourthly for that the common settyng furthe and printig of euery foolishe thyng in englishe, both of physicke vnperfectly, and other matters vndiscretly diminishe the grace of thynges learned set furthe in thesame. But chiefly, because I wolde geue none example or comforte to my countrie men (who I wolde to be now, as here tofore they haue bene, comparable in learnyng to men of other countries), to stande onely in the Englishe tongue, but to leaue the simplicite of thesame, and to procede further in many and diuerse knowledges

bothe in tongues and sciences at home and in vniuersities, to the adournyng of the common welthe, better seruice of their kyng, & great pleasure and commodite of their own selues, to what kinde of life so euer they shold applie them. Therfore whatsoeuer sence that tyme I minded to write, I wrate y[e] same either in greke or latine.

In this quaint phraseology of three centuries and more ago are stated the fundamental reasons why experiment station workers of to-day will do well to publish the major portion of the purely scientific results of their labors not in bulletins, but in established scientific journals. Point for point, the reasons why learned men should publish their best technical results in the best technical manner were precisely the same in the sixteenth century as they are now in the twentieth. Let us see: The "comoditie" of the station bulletin very rarely indeed passes the compass of America, and consequently fails to get the attention of the European workers in the same field. Secondly, the labors taken in the carrying out of a piece of investigation are indeed more than "halfe loste" if the results are published in a bulletin which chiefly comes to the attention of the farmer, who certainly "settes not by learnyng," in the sense that he is in no wise interested in the technicalities of science.

The third point is one about which we can not perhaps expect full agreement, but as honest differences of opinion can do no harm, let me state clearly as my own conviction, that our friend Kaye is right in his assertion that good work is harmed, and the cause for which it stands is harmed, by so publishing it as to invite the unintelligent criticism of uninformed people. This is exactly what we do whenever we publish technical scientific material in bulletins distributed to the general farming public. In spite of the somewhat rabid admonishings which were directed towards the writer when he made the same statement once before, he ventures now to reiterate that the general agricultural public is, as a class, totally incapable of forming any just opinion of the meaning or value of the technical details of scientific work. To invite them to form and express such opinion merely calls down upon the station and the author ridicule or worse. For those, if there be any such still, whose democracy is so intense as to lead them to the conviction that there are no differences between men, and that the humblest hired man on the farm is the intellectual peer of a Newton or a Darwin, the above will sound undemocratic. It really is not. To preserve peace in the family[2] I am willing to admit that *perhaps* we might all be Newtons had we been subjected to the same environment. My only point is that, whether because of heredity or environment, *in real fact* we are not all Newtons. A page of Sanskrit is, I very much regret to say, totally incomprehensible to me. There are many pages of many bulletins which have been issued by American experiment stations which are totally incomprehensible to most farmers. May we not, then, without calling each other names like "codfish aristocrat," let the matter rest here, and turn to Cajus's fourth point? That point, taken over into our present "universe of discourse," is that since a great deal about agriculture that is purely practical, not scientific in any sense, and of an entirely ephemeral nature, has been and is continually published in bulletin form, it can only work to the hurt of first-class research work, such as nearly every one of our stations is producing, to publish it in bibliographical community with the trivial matter which composes so great a part of bulletin literature as a class. Literary and scientific productions, as well as men, are judged by the company they keep.

The fifth and the "chiefe" reason why the stations should publish more of their research work in journals rather than bulletins is because of the educational value of that method for the station men themselves. If a piece of work is submitted to a technical journal for publication, that work must pass a test of merit which is entirely independent of station politics, executive favoritism, the marital connections of the author, the probable effect on the constituency and next year's appropriation, and a host of other things which have been known to play a part in bulletin publication. The work will be judged by the editorial board

[2] But *only* for that reason!

of the journal strictly on its own merits as a piece of scientific research, and on no other basis. Journal publication provides each director with an opportunity to see the scientific work of his station as others see it. Scientific papers are not unlike favorite sons: it is often very difficult for the fond parent to discern in them any faults at all. Independent editorial boards, on the other hand, do that sort of thing very well.

If an independent chemical, or botanical, or zoological, or bacteriological, or agricultural journal refuses to publish a paper submitted from a station, the author and the director are bound to come to the conclusion, since no other is possible, that in some way or other this paper does not measure up to a standard which disinterested experts in the given field of knowledge regard as the irreducible minimum below which sound scientific work can not fall. On the other hand, if it is accepted the work receives the hallmark of standard character.

There is one objection which has been raised to the publishing of a part or the whole of a station's scientific output in different journals which should receive careful attention. This objection is that by this practise the station's work as a whole does not make the impression of large unity which it does if it is all published in one place, namely, the bulletins of the station itself. A somewhat vulgar expression of this same idea which one sometimes hears is that journal publication makes for the aggrandizement of the author at the expense of the station. It has been a theory of station management in some quarters, though now the theory is conspicuous by its nearly complete absence, that the station as such should alone have visible existence and that the individuals composing the staff (save possibly the director) should be publicly considered as invisible, undiscoverable nonentities, not at home. Journal publication has been considered subversive of this pleasant arrangement.

This theory seems to overlook certain facts of psychology, common sense and ethics. It appears entirely clear that the nearer the actual conditions in a station approach to the theory that the members of its staff are individual nonentities, the smaller is bound to be its measure of glory with its constituency and its peers, quite regardless of its mode of publication. For, after all, a station *is* its staff, *et prœterea nihil*.

As a matter of fact, the mere existence of an official institution always suffices to gather to the institution a large part of the *kudos* which may attach to the accomplishments of its component individuals. Plenty of evidence of this, if evidence be needed, is seen in the very small influence an individual can exert except as a member of an organization or institution. And conversely, an institution never gains fame or influence, except through the ability and the achievements of its individual members. The New Paradise Experiment Station is a great station because it has on its staff Dr. J. Doe and Professor R. Roe, who are investigators of great originality and ability, and because its director is a wise and far-sighted man.

To come back to the first point, it is very much to be doubted whether the scattering of the technical publications in journals in any degree detracts from the fame or influence of the station. On the contrary, it is probable that both of these things are considerably increased by this mode of publication. The journals are the standard channel for bringing new results to the attention of the scientific world. They unquestionably reach a much wider audience of scientific men than do the bulletins even under the most favorable circumstances.

So far we have spoken of scientific journals in general. Now let us turn to one in particular, which should interest every station worker in this country, the *Journal of Agricultural Research*. This journal became, almost exactly one year ago, the official organ of this Association and the United States Department of Agriculture jointly. Experiment station papers are received and published on precisely equal terms with department papers. One half of the members of the editorial board are station men. In the editing of the journal the attempt is being made to set a standard as to scientific content and literary form for the papers which shall be as high as the

highest maintained by independent scientific journals, whether in the field of pure or applied science. The journal is being given an extremely comprehensive standard library circulation throughout the world. For the first time it provides a medium of publication, altogether worthy of the best American work in agricultural science.

Will the stations support the *Journal of Agricultural Research* by sending to it specimens of their best output? The past year's experience indicates that the *Journal* meets a real need and will be supported by the stations. Papers have been published or accepted for publication from the following stations: California, Montana, Utah, Minnesota, Illinois, Wisconsin, Michigan, Ohio, Tennessee, Kentucky, both New York stations, Pennsylvania (Institute for Animal Nutrition), New Jersey, North Carolina, Florida and Maine. Which is not a bad showing for the first year!

Altogether it seems to the writer to be inevitable, as the experiment stations take on more and more the character of research institutions, and leave behind more and more that type of activity which was essential at the beginning, but is now being taken over by extension departments, that there will be all the time an increasing proportion of the scientific output published in the standard established scientific journals. In this way only can it take the place which is its due in the world's scientific literature.

RAYMOND PEARL

THE NAVAL CONSULTATION BOARD

THE board appointed by national scientific and engineering societies at the request of the secretary of the navy met in Washington on October 7. Officers were elected as follows:

Chairman, Thomas A. Edison, Orange, N. J.

First Vice-chairman, Peter Cooper Hewitt, New York.

Second Vice-chairman, William L. Saunders, Plainfield, N. J.

Secretary, Thomas Robins, Stamford, Conn.

Assistant to Chairman, M. R. Hutchinson, Orange, N. J.

The board approved a plan for the establishment of a research and experimental laboratory for the United States navy, regarding which a statement was made public as follows:

1. The laboratory should be located on tidewater of sufficient depth to permit a dreadnought to come to the dock. (*B*) It should be near but not in a large city, so that supplies may be easily obtained and where labor is obtainable.

2. The laboratory should be of complete equipment, to enable working models to be made and tested to destruction. There should be: (*A*) A pattern shop; (*B*) a brass foundry; (*C*) a cast iron and cast steel foundry; (*D*) machine shops for large and small work; (*E*) sheet metal shop; (*F*) forge shop for small and large work; (*G*) marine railway large enough to build experimental submarines of 1,500 tons; (*H*) woodworking shops; (*I*) chemical laboratory; (*J*) physical laboratory; (*K*) optical grinding department, etc.; (*L*) motion picture developing and printing department; (*M*) complete drafting rooms; (*N*) electrical laboratory and wireless laboratory; (*O*) mechanical laboratory and testing machines; (*P*) explosives laboratory, removed from main laboratory.

3. The building should be of modern concrete construction, with metal sills and doors, wire glass windows, etc. Ample fire protection.

4. A naval officer of rank should be in charge. He should be especially fitted. (*B*) Under him should be naval heads of broad experience in laboratory methods and science in general—practical as well as theoretical men. They should not go to sea. (*C*) Under them should be staffs of civilian experimenters, chemists, physicists, etc. (*D*) Each sub-head should have his corps of assistants, and with shop facilities, without too much red tape. (*E*) There should be at least two, and possibly three, shifts of men. Time should be the essence of the place.

5. Secrecy should be the governing factor. The place should be surrounded by a high fence and guard maintained at all hours. No visitors allowed.

6. Facilities should exist for enabling the inventor to assist in the development of the idea he has presented, provided he is a practical man.

7. The investment for grounds, buildings and equipment should total approximately $5,000,000.

8. The annual operating expenses to be between $2,500,000 and $3,000,000.

SCIENTIFIC NOTES AND NEWS

THE National Academy of Sciences will hold its autumn meeting at the American Museum of Natural History, New York City, on November 15, 16 and 17.

SECTION II of the Pan-American Scientific Congress will discuss problems of international interest in astronomy and geodesy and in meteorology and seismology. The chairman of this section is Dr. Robert S. Woodward, president of the Carnegie Institution of Washington. It is divided into two sub-sections: astronomy and geodesy, of which Dr. Woodward is the chairman; and meteorology and seismology, of which Professor Charles Frederick Marvin, chief of the United States Weather Bureau, is chairman. Among the topics to be discussed are: (1) The desirability and feasibility of extending a gravimetric survey to cover the American continents. (2) Present condition, needs and prospects of meteorological and seismological work in each of the participating countries of the Scientific Congress. The report from each country should contain a list of all meteorological and seismological stations and other local information pertinent to this report in that country.

TEN additional directors, to represent the important institutions interested in aeronautics, have been added to the executive board of the American Society of Aeronautic Engineers. The appointments are as follows: U. S. Army: Captain A. S. Cowan, commanding S. C. A. S., and Captain V. E. Clark, chief aeronautical engineer, U. S. Army. U. S. Navy: Lieutenant Commander Henry C. Mustin and C. Holden Richardson, naval constructor. Smithsonian Institution: Dr. Albert F. Zahm. Weather Bureau: Professor Wm. R. Blair, in charge of aerological investigation. Bureau of Standards: Dr. D. E. Buckingham. Massachusetts Institute of Technology: Lieutenant Jerome C. Hunsaker, U. S. N. University of Michigan: Dr. Herbert C. Sadler. Aero Club of America: Alan R. Hawley.

THERE has been appointed a British governmental committee to consider and advise on questions of industrial fatigue, hours of labor, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops. The committee is constituted as follows: Sir George Newman (chairman); Sir Thomas Barlow, G. Bellhouse, Professor A. E. Boycott, J. R. Clynes, E. L. Collis, W. M. Fletcher, Leonard E. Hill, Samuel Osborn, Miss R. E. Squire and Mrs. H. J. Tennant.

DR. JOHN D. BLAKE, Baltimore, has been appointed commissioner of health to succeed Dr. Nathan R. Gorter. Dr. Gorter has been appointed a member of the Maryland State Board of Health.

DR. MILTON J. ROSENAU has resigned as a member of the Public Health Council of Boston and has been succeeded by John T. Wheelright.

BEFORE the Geographic Society of Chicago on October 8, a lecture was given by Dr. Henry C. Cowles, of the University of Chicago, on "Romance and Reality from the Mississippi Bottom Lands."

AT the stated meeting of the New York Academy of Medicine, on October 7, Dr. George W. Crile, of the Western Reserve University, delivered the Wesley M. Carpenter lecture on "Kinetic Drive—Its Phenomena and Its Control."

A TABLET was unveiled, on September 18, in Cheltenham College Chapel, and a life-size portrait by Mr. Hugh Riviere in the College Library, to the memory of Dr. E. A. Wilson, who perished with Captain Scott in the Antarctic. The late Dr. Wilson was educated at Cheltenham College.

SUSANNA PHELPS GAGE, known for her work on comparative anatomy, has died at the age of fifty-eight years. Mrs. Gage received the degree of doctor of philosophy from Cornell University in 1880. She was the wife of Professor S. H. Gage.

WILLIAM HENRY HOAR HUDSON, late fellow of St. John's College, Cambridge, and professor of mathematics at King's College, London, died on September 21, aged seventy-six years.

Professor D. T. Gwynne-Vaughan, professor of botany at University College, Reading, died, on September 4, at the age of forty-four years.

J. U. T. Quensel, professor of pathologic anatomy and hygiene at the University of Upsala, has died at the age of seventy-five years.

Dr. Theodor Albrecht, of the Potsdam Geodetic Institute, head of the International Bureau for Geodesy, has died at the age of seventy-two years.

Among those who have been killed while tending the wounded in the field are G. Heimann, of Berlin, one of the pioneers in eugenics, and Professor H. Piper, of the Institute for Physiology, Berlin. Dr. Piper's work was on the physiology of the senses.

The American Academy of Arts and Sciences receives the sum of $3,000 under the will of William Watson, of which he was secretary. Mr. Watson's scientific books and instruments are to be divided among the academy, Harvard University and the Massachusetts Institute of Technology.

It is stated in *Nature* that at the sale by auction of the Amesbury Abbey estate on September 21, the historic monument of Stonehenge was purchased for £6,600 by a local landowner, Mr. C. H. E. Chubb, of Bemerton Lodge, Salisbury. The estate came into the market in consequence of the deaths of Sir Edmund Antrobus and of his only son, who was killed in action last October. As Stonehenge is under the protection of the ancient monuments act, no steps can be taken by the owner to alter or remove any parts of this remarkable relic of antiquity.

The Botanical Society of Pennsylvania held its twelfth annual scientific assembly in Botanical Hall on Saturday, October 2. The program included illustrated lectures by H. H. M. Bowman and Mr. W. R. Taylor, the former on "Botanical Experiences Along the Keys of Southern Florida"; the latter on "Summer Botanizing on Mount Desert." Dr. Joseph S. Hepburn explained his "Experiments on the Digestive Action in the Pitcher Liquids of Nepenthes."

We learn from *Nature* that the members of the Siberian Expedition sent out sixteen months ago, at the joint expense of the Oxford University School of Anthropology and the University of Pennsylvania Museum, reached London last week. The leader, Miss M. A. Czaplicka, is a native of Russian Poland, and has been a student of the Warsaw University and of Somerville College, Oxford. The expedition consisted of Miss Curtis, the artist, Miss Haviland, ornithologist, and Mr. Hull, of the University of Pennsylvania, ethnologist. They proceeded from Warsaw to Krasniack, in Siberia, and thence to the mouth of the Yenisei. The first tribe examined was that of the Samoyeds, and then the winter was spent among the Tungus of the Tundra, a very primitive race, little influenced by Russian culture. The spring was devoted to the Tartars, who are much more civilized than either the Samoyeds or the Tungus. Much information of scientific interest has been acquired, and a large collection of costumes, weapons, implements, and ornaments made of copper and iron has been made. These will, it is hoped, be exhibited later in Europe and America.

The mid-year review of the copper situation by B. S. Butler, of the United States Geological Survey, records a general betterment in the six months' period. At the beginning of the year 1915 most of the large copper producing companies of the United States had for nearly five months been operating on a 50 to 60 per cent. basis and probably none were producing at normal capacity. A considerable proportion of the smaller producers had shut down their plants, where this could be done without great loss. Developments and improvements had been generally suspended. Copper was selling below 13 cents a pound and had been considerably lower. Wages had been reduced in most of the camps and many men had been either laid off or were employed only part time. Soon after the first of the year, however, there was a notable improvement in the demand for copper and the price

has rather steadily advanced from below 18 cents to about 20 cents a pound, the highest price reached since 1907. With the increase in demand, and the advance in price, there has been a corresponding steady increase in the production of the metal and at the present time most of the larger producers have brought their output to normal, while many of the smaller producers have resumed operations. The output of copper has also probably nearly or quite reached the normal. Wages have been raised in the camps where reduction had taken place and the industry in general is in a highly prosperous condition.

In his last report to the Union government of South Africa, as we learn from *Nature*, the secretary for agriculture points out that the difficulty of procuring good men to fill the scientific and administrative posts in the department, which has been commented on before, continues. Men of moderate attainments are plentiful and easy to obtain, but good men are more in request than ever. It also appears as if men who are really worth having, and therefore usually in a position to choose, prefer to work in universities and other learned institutions which are independent or semi-independent of government control, or engage in business on their own account, rather than in government departments, as in the former they have more scope and freedom of action and have not to waste time by furnishing multitudes of returns and continually explaining and demonstrating the necessity for their existence. Seeing that the value of the department to the country depends in the first instance entirely upon the quality of its professional and administrative officers, this is a very serious matter. Efforts are being made to overcome the difficulty of obtaining professional and technical officers by giving scholarships to likely young men to study at institutions abroad, at which they can get the best training obtainable in their particular subjects. The course of study is usually a four years' one, and a number of scholars have already returned and been drafted into the department. It is considered that this is one of the best methods of obtaining officers for the department, but it may not entirely suffice, and from time to time officers will have to be appointed from wherever they are obtainable, as at present.

A report of the chief commonwealth railway engineer, gives some details of the progress of construction of the east-to-west transcontinental railway of Australia, according to an abstract in the *Geographical Journal*. It states that the western Australian division survey is complete, and the route has been permanently located to 280 miles. Thence to the border the permanent survey will proceed in advance of plate-laying. The South Australian survey is complete. It is estimated that the rails will be laid throughout before the end of next year, although the rate of progress will be reduced by the very heavy earthworks soon to be taken in hand in the South Australian section. During the three months preceding the date of the report 240 miles had been laid. The line is to be ballasted throughout, and arrangements had been made to select quarry sites and erect the necessary plant for rock-crushing. In view of the scanty water-supply on the route, reservoirs have to be provided at various points, and several are in course of construction. They include one at Karonia, W.A. (late Cardonia), with an approximate capacity of 7,000,000 gallons; one at Bookloo, S.A. (6,000,000 gallons); and one each at Windabout and Eucla (5,000,000 gallons). Boring operations have been carried on in both divisions.

Radium deposits, the wearing away of the land by the sea, the make-up of the upper part of the earth's crust at various places, the development of mountain ranges, and the origin of dolomitic limestone are some of the subjects discussed in a volume recently published by the Geological Survey entitled "Shorter Contributions to General Geology, 1914." In former years the announcement of incidental discoveries made by geologists in connection with the study of their main problems has awaited the preparation of extended reports on those problems, but by a plan which has recently been put into operation by the United States Geological Survey such minor

additions to the world's store of knowledge, even though unrelated, are now grouped together in one volume and published as promptly as possible. Some of the conclusions in the volume which has just appeared are of interest to the general public; others will be appreciated only by those who have made a special study of geology. For example, the articles on the rock strata known to geologists as the "Montana group" describe the strata which make up that group and their variations from place to place and interpret the facts set forth, giving their significance as to the origin of the strata and the conditions under which they were formed. Most of the field evidence was obtained in examinations of public land for the purpose of determining its value as coal land. The direct results of such work, those which appeal to the man in the street, are the bringing into the United States treasury of some hundreds of thousands or millions of dollars. Indirectly a thorough knowledge of the strata makes the finding of coal and other valuable deposits easier, but the value of the work is not wholly expressible in dollars and cents, for in the realm of pure science the understanding of the make-up of the earth and its history in the past has a value entirely apart from what such knowledge may at present yield directly or indirectly in money. An article on pitchblende ores of Colorado includes not only an account of those ores in that state but also a brief description of the principal European occurrences of pitchblende, one of the ores of radium. An article on erosion in Chesapeake Bay prophesies that certain islands in the bay will be washed away by the waves within the next century and shows the places on the bottom of the bay to which the sand and soil of these islands is being carried by the waves and currents. Another article describes some lavas which have been thrust into cracks in the earth's crust in the vicinity of Spanish Peaks, Colo. Still another article shows that the echinoderms, a class of sea animals, secrete skeletons of one kind of material in cold water and of another kind in warm water, and that the origin of magnesian or dolomitic limestone which has long been a mystery, may be partly explained by the nature of these skeletons, myriads of which make up considerable parts of certain rocks. Several papers discuss the strata underlying the surface of the earth in various parts of the country and give data of use to the driller of deep wells. A copy of this report—Professional Paper 90—may be obtained on application to the director, United States Geological Survey, Washington, D. C.

UNIVERSITY AND EDUCATIONAL NEWS

MR. JACOB H. SCHIFF, a member of the board of trustees of Barnard College and its first treasurer, has given \$500,000 to the college for a woman's building. It will include a library and additional lecture halls as well as a gymnasium, a lunch room and rooms for students' organizations.

THE University of California has received \$100,000 from an anonymous donor to endow the "Dr. C. W. and Mrs. Sarah E. Fox Memorial Beds" in the University of California Hospital, a part of the equipment of the University of California Medical School. These beds are to be maintained in the new University Hospital, now being erected in San Francisco through the gift of \$615,000 by various friends of the university. The superior court of San Francisco has just decided in favor of the university a suit for \$145,000 brought by the regents against the heirs of John M. Keith, who had refused to pay the balance of \$145,000 due under a subscription made toward this new hospital by Mr. Keith, of which but \$5,000 had been called for at the time of his death.

THE will of the late Anna Yarnall creates a trust fund of \$25,000, which is placed in the hands of the trustees of the University of Pennsylvania for the support of the botanic gardens of the Biological Hall at that institution. The income from this trust is to be continued for this purpose as long as the botanic garden is under the supervision of the head of the botanical department.

SINCE the transfer of the department of geology and geography of the University of Chicago to the new Julius Rosenwald Hall, Walker

Museum has been undergoing the necessary alterations so that it may now be used for museum purposes as was originally designed. The building is being thoroughly repaired, a modern lighting system is being installed, and much material of unique scientific value, which has never before been displayed through lack of space, is now being arranged for permanent exhibition. The director of the museum, which contains more than a million specimens, is Dr. T. C. Chamberlin, head of the department of geology; and the associate directors are Frederick Starr in anthropology, Stuart Weller in invertebrate paleontology, and Samuel Wendell Williston in vertebrate paleontology.

The University of Illinois is completing arrangements for the construction of a new genetics building. It will contain offices for Dr. J. A. Detlefson and Mr. Elmer Roberts and two laboratories—one for general genetics and the other for animal nutrition with classroom accommodations. When completed the building will be one story in height, 140 feet by 42 feet in width, and will cost approximately $10,000.

By the will of Mr. W. Jackson, engineer, of Aberdeen, funds are left, subject to his wife's life interest, for the establishment of a chair of engineering in the University of Aberdeen.

Professor Julius Stieglitz has been made chairman of the department of chemistry of the University of Chicago to succeed the late Professor John Ulric Neff.

The Harvard corporation has made the following appointments for the year opening September 27: Dr. John L. Morse, associate professor of pediatrics, has been made full professor; Dr. Frederick T. Lewis, assistant professor of embryology, has been appointed associate professor; Dr. John Warren, assistant professor of anatomy, has been made associate professor; Dr. John L. Bremer, assistant professor of histology, has been made associate professor; Dr. Francis W. Peabody has been appointed assistant professor of medicine and Dr. Herbert S. Langfeld, assistant professor of psychology.

Appointments in the department of agronomy at the Iowa State College for the year include: Ross L. Bancroft, M.Sc. (University of Wyoming and Iowa State College), assistant professor of soils; H. W. Johnson, M.Sc. (Iowa State College), instructor in soils and assistant in soil bacteriology; F. S. Wilkins, M.Sc. (University of South Dakota and Iowa State College), instructor in farm crops, and Roy Westley, B.Sc. (Iowa State College), instructor in farm crops.

Professor A. B. Plowman, Ph.D. (Harvard), has taken up his work as head of the department of biology, in the Municipal University of Akron, Ohio.

Professor Willstaetter, member of the Kaiser Wilhelm Institute for Chemistry, has been made professor of chemistry at the University of Munich.

DISCUSSION AND CORRESPONDENCE

POTASSIUM FROM THE SOIL

Bulletin 182 of the Illinois Experiment Station by Hopkins and Aumer, brings, under the above caption, the results and discussions of a three-year course of experimentation in the growing of crop plants in the "insoluble residue" left after digestion, according to the "official method," for ten hours in HCl of 1.115 sp. g., of a "normal" soil from the Illinois corn belt, of good productiveness. The authors recall that in bulletin 123 of their station it had already been shown that this method of digestion extracted only 15 to 25 per cent. of the total potassium present, as determined by the method of fusion. In the present series of tests it was clearly shown that red clover was able to take from the insoluble residue sufficient potassium to supply a normal crop, so long as nitrogen and phosphorus were adequately present; thus illustrating the futility of the "official method."

It seems proper now to recall to mind that in the early seventies, Loughridge at my suggestion made an elaborate investigation of the effects of the digestion of a "normal" soil with

acids of different strengths, and for different times. The results of this investigation were published in 1873, in the *American Journal of Science*, and in the *Proceedings* of the American Association for the Advancement of Science, having been read before that association. It was conclusively shown that there was a steady increase in the extraction of potassium for *five* days, remaining stationary afterwards, the amount extracted during the first twenty-four hours being about one half of the final figure, while phosphorus, lime and magnesia were fully extracted.

Notwithstanding this demonstration, fully published in two standard publications, a number of years later the "Official Chemists," in a meeting at Washington, hastily adopted, against my protest, the arbitrary ten-hours digestion proposed by Kedzie, as the official method to be used in state and government work.

It is no wonder that as a result of this irrational practise, chemical soil analysis became more and more discredited as a means of ascertaining the quality and permanent productiveness of soils. In cases where potassium was in abundant supply, it gave results corresponding to the field tests because of the complete extraction of phosphates, lime and magnesia during the ten hours' digestion. On the other hand, where potassium was deficient, no definite relation between the analysis and practise *could* appear.

But when Hopkins goes so far as to determine the potassium content by the fusion method, thus decomposing all the resistant silicates, feldspar-sand, etc., as well as the easily decomposable zeolitic minerals, he goes far beyond the limits within which any definite correlation between soil composition and vegetative action is to be expected; and whatever conclusions are based upon such analyses are practically groundless. Knowing as we do that the assimilation of inorganic substances from the soil by plants is mediated by *acid* solvents, whether derived from the air, from vegetable decay, from secretion by plant roots or bacteria, it certainly is most rational to ascertain how far *acid* action can go in the soils under examination. *This* limit, and no arbitrary rule of time, or ultimate analysis, must serve as the basis of judgment for practical comparison of soil values, or producing capacity. Hopkins's own experiments on the growth of plants in the undissolved residue from the "official" analysis simply corroborate what had been abundantly shown by Loughridge's work in 1873, but prove nothing against the practical value of soil analyses properly made. They do throw discredit upon the "official method," so far as potassium is concerned.

But soil chemists would feel additionally indebted to Hopkins if he would undertake to supplement the somewhat gratuitous proof he has given of the inadequacy of the official method, by growing plants on the residue from a digestion carried to the limit of acid-solubility; which in the case of the soil selected by Loughridge and myself we found to be five days for acid of the accepted sp. g. of 1.115. I have long desired to make this crucial test, but have not been able to find the time or means to do so. If an Illinois soil can thus be made to yield to any plant a practically important amount of potassium, it will be very desirable to know it and thus put an end to farther controversy in the matter; while rendering an important service to soil investigation and plant physiology.

E. W. Hilgard

University of California,
September 10, 1915

ELEMENTARY MECHANICS

To the Editor of Science: There have appeared in your pages recently a number of contributions by various authors to the discussion of the dynamical equation $ma = f$ or some of its possible variants. It seems as though it would be necessary, for a complete discussion of the relative merits of the different ways of introducing a student to the dynamical equation cited, to enter at least briefly upon the matter of the student's previous training in mechanics. We are all aware that it is at present somewhat stylish to begin the study of mechanics with kinetics and to treat statics as a special case in which the accelerations are

zero, and impact as a special case in which large forces act through small periods of time. This, however, is a distinctly recent movement. The older method of procedure was to study, first, statics and problems in impact and thereupon to proceed to kinetics. The reason for this order was probably not wholly logical but largely pedagogic or historical. A student who has a small knowledge of trigonometry is quite fitted, mathematically, to study both statics and problems in impact; whereas, to obtain valuable training in kinetics a knowledge of the differential and integral calculus, including the simpler differential equations, is necessary. Moreover, as a matter of history, statics and impact precedes, I believe, kinetics. Let us suppose that the student has followed this historic and pedagogical order. In his statics he will have learned to deal with forces; these forces may be measured in any units that are convenient, provided only that all the forces are measured in the same units in the same equation; for the equations of statics are homogeneous in the forces. (I, of course, am speaking only of elementary statics, not of the theory of virtual velocities or of potential energy.) In studying impact the fundamental conception is that of momentum. The student learns that momentum is the product of mass by velocity; that momentum is resoluble as are forces; and that in impact the momentum of a system is conserved. He is then in a position to solve problems in inelastic impact of particles and, with an additional simple law concerning relative velocities, he can proceed to elastic impact. In the problems in impact the units of mass may also be anything, provided, again, that they are the same for all masses; for here again the equations are homogeneous in the masses.

When, now, such a student comes to kinetics he is able at once to proceed to Newton's second law, namely, that the rate of change of momentum is equal to the force. Here, however, we have an equation which is no longer homogeneous either in the mass or in the force, and it is evident, or can be made so to any student, that he can not use arbitrary units of mass and force, but that the two units must be in some way correlated. Indeed we should state the second law in the Newtonian form: The rate of change of momentum is proportional to, or varies as, the force. We then write

$$\frac{d}{dt}(mv) = kf.$$

The constant k, like any factor of proportionality, is determined by substituting the known values for some special case. We naturally select the simplest; that is, a mass falling under its own weight. If now we measure mass in pounds, as we (probably) did in the theory of impact, and force likewise in pounds, as we (likely) did in statics, we find that the mass of weight W has, under the force of weight W, an acceleration g; hence

$$\frac{d}{dt}(Wv) = Wg = kW$$

or $k = g$. We therefore have the fundamental equation of kinetics in the form

$$\frac{d}{dt}(mv) = gf.$$

If we desire to use some other system of units for mass and force we should likewise have to determine a constant k.

It is, of course, true that a weight is not a definite constant thing from place to place, but I should not think of calling the student's attention very vigorously to this difficulty at this stage, particularly as it again is no difficulty at all, provided mass and force are both measured in weights at the same place. Nor do we need to mention that the equation which involves the momentum is one which can still be regarded as valid when the student reaches the theory of relativity and modern electrodynamics whereas the equation $ma = f$ or any equation involving accelerations leads to the ridiculously needless concepts of transverse and longitudinal (and an infinity of oblique) masses.

It has always seemed to me that the historic and pedagogical method of procedure was still the best, notwithstanding the above mentioned and modern style. It is quite true that from a logical point of view things proceed more simply when we start with kinetics; but logic

is a very poor substitute for common sense, and it is probably logic more than anything else that makes trouble with our pedagogy in mathematics and, even more, in mechanics and physics—perhaps one would hardly try to be logical in theoretical chemistry. Or let us put it another way. There are various kinds of logic; one kind the mathematician's, which to a certain extent is adopted by others; the other kind of logic being the logic of everybody else; a biologist probably has a logic very different from that of the mathematician and very much more useful to him.

From the pedagogical standpoint strict logic, with all its beauties (which the student always misses) is the most illogical thing there is. The important thing for the student and his teacher is to keep as close to every-day life as possible, and any student knows what a weight of 4 pounds is, so that he can proceed to statics. Moreover, he finds no difficulty in measuring the mass or "quantity of matter" by weighing it, so that again he can proceed to problems in impact. The philosophy of mass or force will appeal to him much more after he knows something about mechanics. Our first problem is to get the student into a position where he can solve such simple problems in mechanics as he sees in the actual world on every side about him, and a certain amount of ignorance, which would be very lamentable on the part of myself and your other contributors, is highly praiseworthy in the student.

EDWIN BIDWELL WILSON
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

THE END IS NOT YET!

MR. GERALD H. THAYER in a communication to SCIENCE for September 3, 1915, claims to have disposed of Cory's Shearwater, *Puffinus borealis*, by establishing it as a synonym of *P. kuhli*. He finds this identity first claimed by Saunders and later, finding that Godman in his "Monograph of the Petrels" takes the same view of the relationship of the two birds, he considers the matter settled for all time, adding: "It would seem unnecessary, not to say presumptuous, for us to question this determination, or wait to make further comparison of specimens." Ornithology would be in a sad state if we accepted all statements without attempting verification, and fortunately others have not regarded further investigation in this instance as "unnecessary" or "presumptuous."

Had Mr. Thayer looked into the matter a little more fully he would have found that in the *Ibis* for July, 1914, Mr. D. A. Bannerman questions the correctness of Saunders's and Godman's treatment of *Puffinus borealis* and later[1] he affirms its distinctness. Furthermore, Mr. Bannerman was, quite naturally, struck by the fact that the type of Gould's *flavirostris* came from the "Cape Seas" while the bird to which the name was applied by Hartert was a native of the Azores and other east Atlantic islands. Mr. Thayer passed this matter over without investigation, but Mr. Bannerman upon comparing topotypes of *flavirostris* with the Azores bird found that they represented two different forms and named the latter *fortunatus*. Now the interesting point in all this is that should the bird from our north Atlantic coast be regarded as identical with the Azores form the name *Puffinus borealis* Cory is the oldest name for it and must be used; while if they are regarded as distinct, then the American bird will still be known by Cory's name. In either case we shall retain Cory's Shearwater on our list!

Mr. Bannerman regards all these shearwaters as subspecies of *P. kuhli*, but this does not affect the distinctness of the forms, as the difference between a species and subspecies is not one of degree of difference, but of the presence or absence of intergradation along the line separating their ranges. It must in many cases be largely a matter of opinion, which rank a given form should take. Hasty action like that of Mr. Thayer's, without the examination of adequate material, is responsible for much of the shifting of names back and forth which has become such an abomination in modern systematic zoology.

WITMER STONE
ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA, PA.,
September 4, 1915

[1] *Bull. Brit. Ornith. Club*, May 26, 1915.

THE "PAN-AMERICAN SCIENTIFIC CONGRESS"

TO THE EDITOR OF SCIENCE: You will pardon me if I desire to draw your kind attention to the term "Pan-American Scientific Congress" as applied to the congress which, according to the last issue (No. 1,083) of SCIENCE, is to meet in the city of Washington next December. Scientific bodies are generally understood to represent bodies dealing with science or exact knowledge. Now, inasmuch as geography is a science, and geographical science teaches us that the continent of America includes lands from the northernmost tracts of British America to the southernmost areas of Patagonia, the term "Pan-American" can not be properly applied to any scientific congress, body or society which does not include all the countries and lands of the continent of America.

H. A.

SCIENTIFIC BOOKS

Handbook of Medical Entomology. By WM. A. RILEY AND O. A. JOHANNSEN. Ithaca, N. Y., Comstock Publishing Company, 1915. Pages 1 to 348. Figures 1 to 174.

The writing of a book on a subject to which so many important contributions are being made as to medical entomology is not an easy undertaking. The author is likely to find, when he lays down his pen at the end of a chapter, that an article has appeared which makes it necessary for him to revise his statements in many important particulars. The writers of this book are both successful teachers and the experience they have had in the class room has been brought into play in the manner of presentation of the subject. As a matter of fact six years of teaching medical entomology is undoubtedly the best possible preparation for the writing of such a volume. Consequently it is not surprising, at least to those who are familiar with the work of Drs. Riley and Johannsen, that their "Handbook" is a very clear and logical treatment of the subject with which it deals.

The division of the subject into topics treated in separate chapters is most commendable. The directly poisonous species, the accidental parasites, the simple carriers of disease, the direct inoculators of disease germs, the essential hosts of pathogenic organisms, and other groups are thus treated. The method is undoubtedly more satisfactory from the standpoint of the student than the one followed in many works on the same subject which divide the matter on the basis of the diseases transmitted. Of course it is important to consider the latter phase of the subject and this is done in the series of chapters following those dealing with the different classes of insect transmission of diseases.

The judgment of the authors has been exercised in the discussion of such diseases as poliomyelitis, pellagra, verruga, and others in which insect intervention in any important way has not been fully established. Thus they pursue a conservative course and one which must be beyond criticism by those who are inclined to minimize the importance of insect transmission of diseases.

The last part of the work includes taxonomic tables dealing with ticks, flies, bugs and other insects which are concerned in the transmission of diseases. This is an essential part of the book and will serve as a basis for the work of students for many years.

That the book is up to date is shown by the fact that though the preface is dated January, 1915, it includes, as an appendix, an important article by Stokes which appeared in a medical journal for the month of December, 1914.

The bibliography will be found most useful, although some important works, like Howard's book on the house fly, and a number of articles to which references are made in the early text, are not included.

Recently the center of interest in medical entomology has been England, and the fact that the work of Smith and Kilbourne on splenetic fever in this country, of the American Army Commission which investigated yellow fever in Cuba, and of Ricketts on spotted fever, helped to lay the foundation of our knowledge has to some extent at least been overlooked. The "Handbook" places the relative contribution of different agencies in a clear light but its most important function will undoubtedly be to stimulate interest in

further investigations and to supply a reliable and much needed aid. W. H. Hunter

U. S. Department of Agriculture

Abwehrfermente. Das Auftreten blutfremder Substrate und Fermente im tierischen Organismus unter experimentellen, physiologischen und pathologischen Bedingungen. Von Emil Abderhalden. Fourth, considerably enlarged edition. Published by Julius Springer, Berlin, 1914. Pp. xxiv + 404; with 55 text-figures and four plates.

In the fourth edition of this book, which first appeared about two years ago as a modest pamphlet, especial stress has been laid upon the necessary technique for demonstrating the specific ferments which form according to Abderhalden when any body-alien, tissue-alien or blood-alien proteid, carbohydrate or fat is brought into intimate contact with the tissues of an animal organism.[1] Numerous drawings accompany the text and detailed instructions are given for the various preparations and manipulations which must always be carried out with rigid aseptic precautions and with adequate controls. Sources of error are exhaustively treated and indeed are so numerous that perhaps any failure could be explained by some slip in technique. This technical part occupies one half of the book, the other half being devoted to an exposition of the theory and its numerous stimulating corollaries.

It is unfortunate that the method has not been simplified, for its difficulty is probably the main cause of the disagreement which still exists among competent investigators about the availability of Abderhalden's methods in the serodiagnosis of organic functions.

The widespread attention which Abderhalden's important work has aroused is well shown by the appended bibliography, which, though incomplete, numbers more than 300 titles.

The book is written with expository skill and with charm, and will be read with interest and profit even by those who are in scientific disagreement with its teachings. John Auer

Rockefeller Institute

[1] See the review of the second edition, Science, 1913, N. S., XXXVIII., No. 988, p. 820.

Sun Lore of All Ages. By William Tyler Olcott. G. P. Putnam's Sons. 1914. Pp. xiii + 346. Illustrated.

The setting of the dimmed sun in the west at night and its rising, refreshed and glowing, in the east on the following morning, presented a mystery to the early peoples of the world: to the dwellers in ancient Egypt, to the Incas of Peru, and to the Indians of our western plains. This mystery has been solved in many ways and has given rise to numberless legends, traditions and superstitions. These traditions Mr. Olcott has traced, the legends and superstitions he has collected and compared, and has formed the whole into a very readable and attractive book. The work, which is a worthy successor to the author's "Star Lore of All Ages"; is well printed, beautifully illustrated, and forms an attractive addition to any library.

Chas. Lane Poor

HEMOGLOBINOPHILIC BACTERIA

The hemophilic or more properly hemoglobinophilic bacteria comprise a rather large group of bacilli which grow only in an artificial medium containing hemoglobin. This group does not include the many bacteria that, while growing better in media containing blood or blood serum, will also grow in media not containing hemoglobin. Its representative organism and by far its most important member is the influenza bacillus (*B. influenzæ*) which was discovered by Pfeiffer (hence commonly called Pfeiffer's bacillus) in the respiratory tract of patients afflicted with influenza during the great pandemic in 1889–90. Not only did he discover and isolate this organism at that time but he definitely proved its hemoglobinophilic character a property of bacteria hitherto unknown.

In his classical paper[1] in which he reported these researches he also described other organisms differing in certain respects from the true influenza bacilli, but similar in being hemoglobinophilic. These he called pseudoinfluenza bacilli. Since then these pseudo forms, which

[1] *Zeit. f. Hygiene*, 1893, 13, p. 357.

have also come to be referred to as influenza-like bacilli, have been found especially in the upper respiratory tract in a great variety of diseases. They are frequently met with, for example, in measles, whooping cough, bronchitis, diphtheria, chickenpox, pulmonary tuberculosis, bronchiectasis, pneumonia, and occasionally, as the writer has shown, in apparently normal throats. These bacilli are all very similar, indeed, practically identical, and more recent work seems to indicate that they are also probably identical with the true influenza bacillus differing from it only perhaps in respect to virulence.

Bacilli of this group vary greatly in this respect. As an illustration may be cited the organisms of this type which not uncommonly cause acute meningitis in children. They are found in immense numbers and often in pure culture in the spinal fluid and in the meninges of such patients. They seem to be identical with the true influenza bacilli, having, however, a much higher degree of virulence for animals. In rabbits, for example, after inoculation they may produce death by true septicemia, a result usually not possible to obtain with ordinary doses of Pfeiffer's bacillus.[2]

A further point of interest in connection with all the above bacilli is the fact that when grown on media in the presence of other bacteria, for example, streptococci, staphylococci, etc., they multiply more rapidly, their colonies are larger and their virulence for animals is increased. In other words, they clearly show, to a marked degree, the property of symbiosis.

Several other varieties of hemophilic bacilli differing in certain respects and especially in relation to symbiosis have been described by a number of observers. Friedberger[3] found in the preputial secretion of dogs such an organism, a very minute, gram negative, non-symbiotic, non-pathogenic bacillus. Several years ago the writer[4] described a somewhat similar bacillus isolated from the pathological urine, in three patients in which there was evidence that it had a causal relationship to the infectious process, and since then C. Koch[5] has described an identical bacillus which he believes to have been the causal organism in a number of cases of puerperal infection.

Recently the writer obtained a bacillus from a large abscess of the shoulder joint in an infant a few months old. Not only cultures of pus from the abscess obtained by aspiration, but also cultures of blood obtained from the median basilic vein gave a pure growth of the minute bacillus which was strictly hemoglobinophilic and which resembled closely the influenza bacillus in all respects except in its symbiotic property. The same bacillus was grown from the bronchial secretion and it was probably from this source that the organism first entered the circulation and later localized in the shoulder joint.

In the literature there are a few other isolated instances where bacteria of this general type have been encountered.

These bacilli are interesting in that they are pure parasites, for the very evident reason that only in animals can they find the hemoglobin which, so far as we know, is absolutely necessary for their existence. And since they are not spore formers and are all very delicate organisms, their length of life outside the animal body is very short, probably a few days at the most.

The rather remarkable and extreme adaptation which they have undergone in relation to hemoglobin is also an interesting and important biological phenomenon. While hemoglobin seems indispensable for their growth certain closely related respiratory pigments, for example, hemocyanin and hemerythrin, which occur in the blood of some of the lower animals and appear to have a function similar to hemoglobin in the higher forms, can not be utilized.[6]

The exact rôle which hemoglobin plays in their metabolism is not known. They seem to be able to use this substance about equally

[2] Cohen, *Ann. de l'Inst. Past.*, 1909, XXIII., 273.

[3] *Cent. f. Bakt.*, I., 193, Orig. 33, p. 401.

[4] *Jour. of Infectious Diseases*, 1910, 7, 599.

[5] *Zeit. f. Geburtsh. u. Gynäkol.*, 1912, LXIX., 634.

[6] Davis, *J. Inf. Dis.*, 1907, 4, 73.

well from nearly all the higher forms of animal life, though the hemoglobin from the pigeon as a rule gives a somewhat more abundant growth. It is doubtful whether the hemoglobin is necessary on account of its nutritive properties, because extremely minute quantities in media suffice for growth. The phenomenon may be, therefore, a catalytic one; but further study along this line is needed to prove this point.

There are other points concerning these bacteria which need further investigation, for example, the phenomenon of symbiosis above referred to. In this regard many bacteria occurring in the lower animals should be studied and we should also study and record more thoroughly than has been done, the properties of the non-pathogenic bacteria in this respect.

This group of organisms it seems to me has not received as much attention as it deserves by bacteriologists in general. To illustrate this, I might call attention to the fact that in the very excellent and serviceable descriptive chart for bacteria prepared by the Committee on Methods of Identification of Bacterial Species and endorsed by the Society of American Bacteriologists no provision has been made for recording the properties which bacteria manifest toward blood. This not only applies to the group of hemophilic bacteria but also to many bacteria which have the property of hemolyzing blood and therefore commonly called hemolytic bacteria. Hemolysis is an important characteristic of certain bacteria, for example, streptococci, cholera vibrios, etc., and being fairly constant and quite readily determined by several methods it has come to be of real practical value in the identification and differentiation of organisms.

DAVID JOHN DAVIS
UNIVERSITY OF ILLINOIS

SPECIAL ARTICLES

ARTIFICIAL DAYLIGHT FOR THE MICROSCOPE

AN examination of the laboratories for students, investigators and private workers with the microscope in our country will show that a very large number can not employ daylight, but must depend on artificial light, although increasingly in biology and pathology stains of all shades and combinations are used to color the objects studied to bring out their structural details.

As daylight is the form of light for which the human eye was developed in the course of its evolution, and as it is the only light which gives to the eye the true color values of the objects in nature, and the multitudes of artificially colored objects in the industries, arts and sciences, naturally many efforts have been made to render artificial light more like daylight.

The accompanying diagram shows very strikingly the difference between daylight and the light from a nitrogen-filled tungsten lamp. The lamp-light is *relatively* too strong in all the colors beyond the violet, and the difference becomes very great in the green and the red. In the other artificial lights commonly used, except the arc, the difference from sunlight is even greater.

As can be readily seen, in order to render any artificial light like daylight, the values of the various colors of the spectrum must be like those of daylight; and this can be attained only by reducing the excess of the red, green and other colors in the spectrum of the artificial light in such proportion as to make the energy curve of its spectrum like that of the sun.

Until very recently all the efforts to make a light filter or screen for artificial light which would transmit light having daylight qualities by which colors could be detected and discriminated with the same certainty as in daylight, were unsuccessful.

During the last two years Dr. Henry Phelps Gage, working in the laboratories of the Corning Glass-works, with the facilities there found, has developed a glass filter which renders the light from a nitrogen-filled tungsten lamp almost exactly like daylight.

In his own words:

> The investigation was started with the idea that a very close approximation to the theoretical requirements would be necessary, and the results have justified the belief that the most perfect approximations are the best.

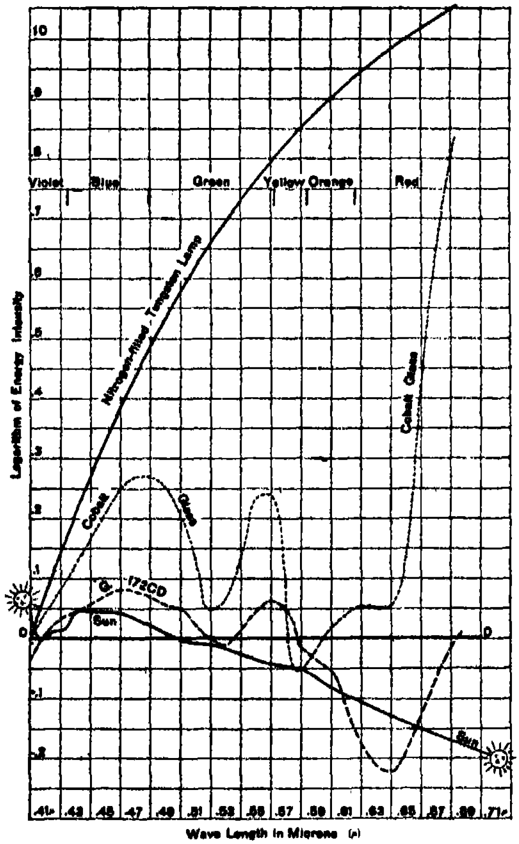


DIAGRAM SHOWING THE DISTRIBUTION OF ENERGY IN THE VISIBLE SPECTRUM OF SUNLIGHT AND OF THE LIGHT FROM A NITROGEN-FILLED TUNGSTEN LAMP; also of the lamp-light filtered through cobalt glass and through the daylight glass (G.172 CD).

The accompanying diagram shows the distribution of energy in the spectrum of sunlight and of the nitrogen-filled tungsten lamp; it also gives the curve of the light from the nitrogen-filled tungsten lamp filtered through cobalt glass and through the daylight glass, 172 CD.

The curve for the light filtered through the daylight glass approximates very closely to that for sunlight, especially between wavelengths $.45\mu$ and $.65\mu$, that is, in the region of the visible spectrum giving the greatest amount of useful light.

While light filtered through the proper thickness of cobalt glass may look white to the eye, it gives even more imperfect color values than the unfiltered artificial light. This is intelligible from the violent irregularities of the curve of the light through cobalt glass, and especially the enormous excess in the red as shown in the diagram.

Light filtered through the daylight glass has been very critically tested in my laboratory with microscopic objects stained with many different dyes, and some of them with several dyes on the same specimen to differentiate the various structural details in the same organ. To make sure that the microscope modified in no way the color values, apochromatic objectives and compensation oculars were used as well as the achromatic objectives and Huygenian oculars.

The tests were made in the daytime by a window so that it was possible to turn the mirror from the artificial daylight to true daylight instantly and to determine any difference in appearance, if such difference existed. It was impossible to detect any difference in the colors, although tests were made with the most varied specimens and with a full range of objectives, including the 1.5 mm. oil immersion.

Not wholly trusting my own judgment, I secured that of colleagues in histology and embryology and microchemistry from our own and five other institutions, and their judgment entirely confirms my own.

In practise it was found desirable to have the daylight glass finished with the ground or velvet surface on one or both sides, and to place it in the opening of an opaque screen between the artificial light and the microscope. With this arrangement of the light, the effect is like that from a white cloud.

As stated above, this glass filter was designed to give daylight qualities to the light from a nitrogen-filled tungsten lamp, and gives the most perfect and satisfactory illumination for the microscope with this lamp. To thoroughly test the glass, the other light sources used in microscopic work were also tried; viz., the vacuum tungsten, and the carbon-filament

lamps, illuminating gas with welsbach mantle, acetylene and finally the flat-wick kerosene flame. None of these other sources gave exactly the same color values as daylight. However, the approximation to daylight was surprisingly good, and the worst one, *i. e.*, the kerosene flame, gave better color values than the best artificial light without the color screen. The original intensity of the carbon-filament lamp and the kerosene flame is not great enough to give the best results with the daylight glass. This is because much of the artificial light must be absorbed to render it like daylight.

To the writer it seems that this glass must be a great boon to all those who must use the microscope with artificial light. As the light is soft like that from a white cloud, the comfort to the eye is most gratifying; and of almost equal importance, it gives certainty in distinguishing the most delicate colors and the various combinations of colors. It seems, furthermore, to promise great help in the textile and dye industries, in chemistry and in medicine, as it offers a standard daylight without the changes of real daylight depending on whether the sun is shining or whether the light is from the blue sky or from a cloudy sky. And finally it is believed from the experiences of the writer, that it will furnish great relief to those with sensitive eyes who must work by lamp-light, as it renders the light soft and agreeable like the most favorable daylight.

SIMON H. GAGE
LABORATORY OF HISTOLOGY AND EMBRYOLOGY,
CORNELL UNIVERSITY

A NEW ALFALFA LEAF-SPOT IN AMERICA

WHILE passing an alfalfa field in the vicinity of Manhattan, Kans., in October, 1914, the writer's attention was attracted by the irregular stand, which was noticeable from the road. Since light frosts were rather frequent at the time of year, the condition of the alfalfa was at first thought to be due to these, but closer examination indicated that these could not be the cause. Careful investigation showed that a leaf-spot was prevalent on many of the plants, and that it was strikingly different from anything with which the writer was familiar.

The plants affected were not producing a normal amount of foliage, the stems being sparsely set with spotted leaves, which were affected with a singular leaf-spot. The diseased plants thus presented an unthrifty appearance, and were also somewhat smaller than normal plants.

Since this was discovered on the last crop of the season, there was a question in the writer's mind whether it would be confined mainly to the latter part of the alfalfa season, or would make its appearance on the earlier crops. In the present season a close watch was kept on the first crop. The disease was again located in the aforementioned field on April 17, 1915, and further investigations have shown it in a number of fields belonging to the agricultural college. Furthermore, specimens have been collected in different localities within this state and other states. It has likewise appeared to a greater or less extent in the second and third crops in Kansas.

The material collected last fall was studied in the laboratory this winter, and cultural and inoculation experiments are now under way. There is no question as to its pathogenicity. The fungus is an ascomycete, the perfect stage (perithecia) being found in the mature spots. It belongs to the genus *Pleosphærulina*. The writer has been unable to locate any literature pertaining to its occurrence in America. The species has not been definitely determined. An alfalfa leaf-spot due to *Pleosphærulina Briosiana* Pollacci has been reported by Pollacci,[1] Bubak[2] and Puttmans,[3] in Italy, Austria and Brazil, respectively. There is some doubt, however, whether the species with which the writer is working is *Briosiana* Pollacci,

[1] "Spora una nuova malatta deil erba medica," *Atti del Instituto Botanico, dell' Università di Pavia*, Nuova Serie, Vol. II., Serie 1901.

[2] "Eine neue Krankheit der Luzerne in Osterreich," Wiener Landwirtschaftliche Zeitung, Nov. 20, 1909, Nr. 93, s. 909.

[3] "Diseases of Cultivated Plants," *Revista Agricola Sao Paulo*, Nos. 114–125, pp. 379–381, 1905.

since Bubak,[2] in his description of this alfalfa leaf-spot, states that a perithecium does not contain more than three or four asci; while, in the material at hand, the number varies from 8 to 14. Furthermore, the ascospore and ascus measurements do not agree entirely with those given by Pollacci,[1] or Bubak. Pollacci first reported and named the fungus in Italy. He does not give the number of asci in a perithecium, and his ascospore and ascus measurements do not agree with those by Bubak, although the latter regards the species as the same. Puttmans[3] describes a variety, naming it *Pleosphærulina Briosiana* Pollacci var. *Brasiliensis* Puttmans nov. f. He regards it as different from *Pleosphærulina Briosiana* Pollacci, in that the ascus and ascospore measurements are larger. Among the seven species under the genus *Pleosphærulina,* described by Saccardo,[4] including *Briosiana,* nothing further is elucidated.

A description of this alfalfa leaf-spot as it occurs in Kansas is as follows: The spots are scattered irregularly over the entire leaf surface, frequently causing spots along the margins. These spots are generally circular or elliptical, from 1 to 5 mm. in diameter. During the earliest perceptible stages, the spots appear as very small, dark-reddish-brown spots. These soon increase in size, a dark-brown margin bounding the ashen-gray center of the spot. The centers of these spots may vary from a light tan color to ashen-gray. This tissue does not fall out, but remains intact. The spots are confined almost exclusively to the leaves, but the fungus does attack the petioles. The perithecia are visible to the unaided eye if they are mature, appearing as very small black dots. They occur rather sparingly, irregularly and promiscuously scattered within the centers of the spots. They are more or less membranous, partially immersed, erumpent, globular to oblong, slightly pyriform, glabrous, dark brown to black, 100–120μ in diameter. The asci are ovoid in shape, varying from 8 to 12 in number, and measuring 56–75μ long, and 38–42μ wide. There are no paraphyses, which fact distinguishes this fungus from the genus *Catharinia.* The asci are supplied with a pedicel at the base, with which they are attached to the wall of the perithecium. Each ascus is provided with a peculiar tongue-like projection at the apex, this being a striking characteristic. This does not appear to be described or mentioned, so far as the writer has been able to find, in Pollacci's description of this fungus. The ascopores measure 12–14μ wide, and 30–32μ long. They are generally arranged so that 5 ascospores are located at the base and larger end of the ascus, and 3 in the upper or narrower part. The spores are multicellular, oblong, fusiform, conspicuously granular, and greenish-hyaline, and having from 3 to 4 septa, and from 1 to 3 longitudinal divisions, making from 5 to 7 cells, rarely 8.

[4] Sylloge Fungorum., Vol. XI., XIV., XVI. and XVII.

This leaf-spot may prove to be of considerable economic importance, since like the *Pseudopeziza* leaf-spot, it causes destruction of the foliage.

LEO E. MELCHERS

DEPARTMENT OF BOTANY,
KANSAS STATE AGRICULTURE COLLEGE

DIFFERENTIATION OF WANDERING MESENCHYMAL CELLS IN THE LIVING YOLK-SAC

THE yolk-sac of the teleost egg is a particularly favorable object for observing the movements and migrations of cells in the developing embryo. Such a yolk-sac has only one really definite continuous membranous cell layer, the ectoderm; a true endodermal layer is absent, though a superficial syncytium, the periblast, fuses with the actual yolk surface. The mesodermal layer is represented by numerous separate wandering mesenchymal cells. These freely wandering mesenchymal cells may be clearly observed through the perfectly transparent ectoderm as they move over the surface of the periblast.

The writer has attempted a detailed study of the movements of the mesenchyme cells and their manner of development and differentiation on the yolk-sac. Observations have been made on the normal embryos from the earliest stages at which the mesenchyme wanders out upon the yolk up to the late embryo in which a com-

plex vitelline circulation is fully established, and all of the products of the yolk mesenchyme completely differentiated. The study has been greatly facilitated by a comparison of the normal embryos with specimens in which the circulation of the blood was experimentally prevented from taking place. In such specimens the cells on the yolk-sac never became confused or contaminated with other cellular elements introduced by the circulating blood. The wandering cells may thus be completely followed through all stages in their isolated position.

In the first place, I can not resist the impulse to highly recommend that all students of hematogenesis spend some time at least in a study of living mesenchymal cells and their histogenesis. Such a study will soon convince one of the great disadvantages under which an investigator labors in attempting to solve the origin of blood from observations on dead material in serial sections. The problem becomes so simplified and devoid of laborious uninstructive technique that it seems almost superficial. One may learn as much from the living yolk-sac in an hour of careful study as in almost a week's perusal of sections. Most important is the fact that certain things may actually be seen to occur that sections could scarcely stimulate the mind to imagine. The only disadvanage is that the worker may be led to wonder whether so apparently simple a problem is actually of scientific importance. Fortunately, this mental state is soon passed over on realizing the necessary care and precaution which must be taken in following the movements and changes in the living cells.

Each cell is to be recognized as a living complex and the observer will realize the importance as well as the difficulties of thoroughly understanding and interpreting correctly its manifold changes and behavior. Material which to some extent allows such a study is often available. The *Fundulus* yolk-sac, however, is exceptionally adapted to this study on account of the beautiful simplicity of its structure, as well as the remarkable clearness with which each cell may be observed.

The results of this investigation of wandering mesenchymal cells may be summarized as follows:

The wandering cells begin to migrate away from the embryonic shield or line of the embryonic body at an early period, when the embryo is about forty hours old, the germ ring having almost completely passed over the yolk sphere to enclose its vegetal pole. The cells migrate away chiefly from the caudal end of the embryo, only a few wandering out from the head region. The regions of the yolk-sac thus suggest an area opaca about the tail end and an area pellucida around the neighborhood of the head.

All of the cells wander into the so-called subgerminal cavity, the space Wilson[1] and others consider a late stage of the segmentation cavity, between the yolk-sac ectoderm and the periblast syncytium.

When the cells first appear they are all closely similar in shape and about the same size. Very soon, however, they begin to exhibit certain differences. Many become elongate spindle cells with delicate filamentous processes, sometimes producing a stellate appearance. Others are more ameboid in shape with conical pseudopod-like processes which are constantly being thrown out at one place and withdrawn at another. Still a third class of cells appears somewhat later than the other two; these are more circular in outline with short pseudopods and are more slowly moving.

The movements of these extremely numerous cells and their changes of position may be readily followed with a high magnification. In embryos of about sixty hours, still some time before the heart begins to beat or the blood to flow, four clearly distinct types of cells can be recognized among these originally similar mesenchymal cells, and the further history of the four types may be completely traced.

The ameboid cells with conical pseudopod-like processes shortly after sixty hours begin to show an accumulation of pigment granules within their cytoplasm. Just at this time they are seen to be of two distinct varieties,

[1] Wilson, H. V., "The Embryology of the Sea Bass (*Serranus atrarius*)," *Bull. U. S. Fish Com.*, 1891.

one depositing a black and the other a brownish-red pigment.

The black chromatophore increases rapidly in size and by the end of the third day becomes an enormous ameboid body wandering over the yolk. These cells are attracted to the walls of blood vessels and plasma-filled spaces, such as the pericardial cavity becomes in individuals without a blood circulation. When the embryo is five days old the chromatophores are abundantly arranged along the walls of the vitelline vessels, but the pigmented cells are distinctly separate. After this time neighboring cells begin to fuse along their adjacent borders and large pigment syncytia are formed which completely surround and ensheath the vessels. A single syncytium is often of considerable extent.

The brown chromatophores have a somewhat different history. They never become so massive as the black, and their processes are more delicate and graceful in appearance. Yet these cells also attain a large size and in embryos of 72 hours are scattered over the entire yolk-surface. After the third day when the blood begins to flow in the yolk vessels, the brown chromatophores likewise become attracted to the vessel wall. These exquisitely branched cells apply themselves to the wall of the vessel and may often completely surround it. This type of chromatophore, however, always maintains its cellular individuality and never fuses with other cells to form a syncytium, as is the case with the black type.

The function of the chromatophores on the yolk-sac is most difficult to decide, but one thing is certain, they never become changed into any type of blood cell. The brown chromatophore in early stages may accidentally reach the blood current; it then becomes spherical and may readily be observed for a long time on account of its huge size as compared with the blood cells. It never, however, changes in type.

In specimens without a circulation of the blood both types of chromatophores arise in a normal manner and differentiate normally. Their arrangement along the vessel walls fails to occur. The chromatophores, therefore, remain scattered over the yolk or collected about the plasma filled spaces. The heart in such embryos is sheathed with pigment, while the normal heart never has a chromatophore on it.

The elongate spindle cells with their delicate filamentous processes are small in comparison with the two chromatophore types. These spindle cells retain in general their original appearance, but their behavior is most important. In embryos of about forty-eight hours such cells aggregate into certain rather definite groups; later, the groups become more linear in shape and finally these lines of cells arrange themselves so as to form tubular vessels. Several of the larger vessels arise independently upon the yolk, and certain ones of them later become connected with the venous end of the heart, while in all cases capillary nets which also arise independently become connected with the larger vessels. These processes may actually be followed through every step in the living yolk-sac.

The wall of the early vessels is very irregular, with spaces existing between the component cells. Corpuscles are often caught in these spaces or are entangled in the filamentous processes of the endothelial cells. Such conditions in sections would appear as though the corpuscles actually formed a part of the endothelial wall and might incorrectly be interpreted as endothelial cells changing into blood cells. Nothing has been seen in the living embryos to indicate that an endothelial cell has the power to produce a blood cell or to change into a blood cell of any type, but much has been seen to the contrary.

The generalization strikingly made by Thoma[2] that larger vessels arise from a network of capillaries is not true for the large vitelline vessels of the fish yolk-sac. In the specimens without a circulation of the blood the vessels arise and increase in size and persist for a long time without ever experiencing any effect of the blood current upon their walls.

[2] Thoma, R., "Untersuchungen ueber die Histogenese und Histomechanik des Gefässsystems," Stuttgart, 1893, and "Text-Book of General Pathology and Pathological Anatomy," trans. by Bruce, London, 1896.

In many embryos the circulation after having begun may stop for a time and then later be reestablished, the vessels having persisted in a normal condition. Thoma's so-called laws of vessel formation are, therefore, rudely violated by the development of the vascular system in these embryos.

The vessels arising from independent mesenchymal cells in the space of the blastocele in the teleost yolk-sac entirely overthrow any notion that vessels arise ontogenetically as portions of the celomic epithelium. The vascular lumen is originally continuous with the primary body cavity, the segmentation cavity, and never with the secondary body cavity, or celomic cavity.

The fourth class of cells wander out from the embryonic body somewhat later than the three former types. These are small circular cells with short pseudopod-like processes. They move very slowly, but finally collect into groups on the posterior and ventral regions of the yolk-sphere.

The round cells wander away only from the caudal region of the embryo and probably are derived from the so-called intermediate cell mass which is the anlage of the red blood corpuscles in the fish embryo.

The groups of round cells are slow in their differentiation but just before the circulation of the blood begins, they are seen to be circular erythroblasts. The observer may follow the disappearance of the islands of cells one by one as they are enclosed by the vessels and swept into the circulating stream. About the fifth day these circular erythroblasts become flattened ellipsoidal erythrocytes filled with hemoglobin, the typical red blood corpuscle. The complete change from wandering, more or less globular mesenchymal cells into typical hemoglobin-bearing corpuscles may be followed in the living yolk-sac.

In several instances the body proper of the embryo failed to develop or else degenerated very early, yet the yolk-sac formed or persisted with numerous blood islands fully differentiated.

The embryos in which there has been no circulation of the blood form the blood islands from the wandering cells on the yolk-sac, and the *constituent elements* of these islands differentiate perfectly and may maintain their red color for many days. Yet they never leave the locality in which they have differentiated. The fully formed red blood corpuscles have little if any power of migrating. When the observer can be positive that the blood has never circulated, and this requires very consistent watching, the blood islands of the yolk-sac are always limited to certain regions, and never occur so far anteriorly on the ventral surface of the yolk as to reach the venous end of the heart.

Finally, we may consider the study of the developmental products of the early wandering mesenchymal cells on the yolk-sac of the *Fundulus* embryo as a problem of cell lineage followed to its ultimate end. The primordial mesoderm cell or cells carry within their bodies all the potentialities of the mesoderm and may give rise to a series of cells which are capable of developing muscle, cartilage, bone, connective tissue proper, blood cells, vessels, etc. Yet after a few cell generations the individuals in the series derived from these early cells containing all the mesodermal potentialities no doubt become somewhat limited as to their potentialities. In a certain generation there may be definite cells more or less generally distributed which possess the capacity to give rise to muscle cells, but to no other type of mesodermal tissues. Still later in development these cells may become even more limited in their developmental capacities and thus have the power to produce only a certain type of muscle cell and no other type.

Collections of such cells would then be designated embryologically as the anlage of striated muscle, smooth muscle or heart muscle, as the case might be. Yet it is not to be forgotten that at this stage there might be really no means of distinguishing between the several different types of mesodermal cells.

Limitization of potentialities in the individual mesenchymal cells has apparently reached a comparable stage just about the time when the cells begin to wander upon the yolk-sac of *Fundulus*. We have seen these cells as

they wander out and have noted how very soon they may be separated into four distinctly different types, and following the development and behavior of these types it has seemed evident that they are entirely separate and do not intergrade or transmutate. The black chromatophore does not change its nature or divide off other cells which become different in type from the parent cell. Neither do the endothelial cells lining the vessel walls change into chromatophores or into erythroblasts, or vice versa.

From the observations on these yolk-sacs we must conclude that the four types of cells described above have developed from four different anlagen, although these anlagen were not necessarily localized groups of cells, but were diffusely scattered mesenchymal cells capable of developing into a definite product, either normal or abnormal, depending upon the nature of the developmental environment. Therefore, the four distinct mesenchymal anlagen each gives rise to a perfectly typical and distinct cell type, although all develop in, as far as is possible to judge, an identical environment, the cavity of the yolk-sac between the ectoderm and the periblastic syncytium. The differences among the four cell types produced are from the standpoint of our present knowledge in all probability due to the potential differences among the apparently similar mesenchymal cells from which they arose. The four types including endothelial cells and erythrocytes we must consider, from an embryological standpoint, as being polyphyletic in origin.

C. R. Stockard

Woods Hole, Mass.,
September 15, 1915

ANTHROPOLOGY AT THE SAN FRANCISCO MEETING

A special meeting of the American Anthropological Association was held in the Museum of Greek Sculpture and Anthropology, University of California, Berkeley, August 3 to 5, 1915, in affiliation with Section H and the American Anthropological Association. In the absence of Professor A. L. Kroeber, chairman of the committee on program, Professor T. T. Waterman, vice-chairman, presided. Although the program was a comparatively short one, the attendance at the meetings was large.

Papers of interest to anthropologists were also read before the joint meeting of the American Psychological Association and Section H; and before the Archeological Institute of America. However, the abstracts which follow will be confined entirely to the papers read before the Anthropological Association. For example, among the papers read before the Archeological Institute should be mentioned "Ancient Mexican Spindle-whorls," by Mrs. Nuttall, which was illustrated by an exhibit of two hundred specimens, as well as by reference to one of Lord Kingsborough's volumes; "Life Forms in the Pottery of the Southwest," by Mrs. Harry L. Wilson; "Aspects of Neolithic Culture of the Santa Barbara Channel Islands, California," by Hector Alliot; "Latest Work of the School of American Archeology at Quirigua, Guatemala"; and "Archeology at the Panama-California Exposition," by Edgar L. Hewett; and "The Unpublished Material in the Mayance and Southern Mexican Languages," by Wm. E. Gates.

The papers read before the American Anthropological Association included: "A Demonstration of the Skull of an Ancient San Diegan Indian Showing the Largest Coronoid Index yet Recorded" (by title), by J. C. Thompson; "Differences in Papago and Pima Coiled Basketry" (by title), by Mary Lois Kissell; "Kumana, a Primitive Corner of Japan, and Its Folk-Lore, as Studied by Mr. Minkata" (by title), by W. T. Swingle; and "The Significance of the Present Forward Movement in China," by Yamei Kin.

Abstracts of all the other papers presented follow:

The Miwok Moieties: E. W. Gifford.

The Central Sierra Miwok Indians of the Sierra Nevada Mountains of California are divided into exogamous moieties with paternal descent. Each moiety is associated through the personal names of its members with either the "water" or the "land" side of nature, this division of nature being more or less arbitrary. The object after which a person is named does not appear, as a rule, in the name itself; it does appear, however, in the connotation of the name. The connection thus existing between the moiety and a group of natural objects lends a totemic aspect to the Miwok moieties, which is supported by a myth attributing the parentage of the founders to the bear and the coyote. The moieties are practically impotent as

ceremonial factors, their chief function being the regulation of marriage.

The system of relationship contains thirty-four terms, and in certain features closely parallels the systems of the southern Siouan tribes, notably the Omaha. A striking feature is the placing of cross cousins in two generations, which results in the use for cross cousins of terms meaning son, daughter, stepmother, uncle, niece, nephew. This feature is correlated with the marriage of a woman to her father's sister's husband.

Cross cousin marriage is limited to one pair of cousins only, who use the terms meaning son and stepmother. The theory is advanced that the Miwok type of cross cousin marriage originated through the influence, upon the institution of marriage, of wife purchase and descent in the male line.

Demonstration of a Series of Philippine Skulls from Bohol: LUTHER PARKER.

The number of skulls under discussion is seven. These skulls were collected in a limestone burial cave on a promonotory near the barrio of Tiagas in the town of Loay, Bohol Province, by the writer personally. In addition to the skulls, he also secured the lid of a coffin, some ornaments and pieces of pottery both native and Chinese. A few steel or iron spear heads and parts of blades were likewise obtained.

It is probable that the articles collected were deposited in the cave not later than A.D. 1600, since the conversion of Bohol to Christianity took place about that time. As to how much earlier the cave was used it is not possible to state, but probably not earlier than A.D. 500. Native traditions do not fix the time of these burials, but deal only with the custom of borrowing the pottery and ornaments for use in fiestas, this custom having been quite widely distributed.

Cave burial seems to have been practised quite extensively in the Bisayas and to some extent in northern Luzon among the Igorots and in the Batanes Islands. Jar burial both in caves and out was also practised in the Bisayas and in the Bobuyanes north of Luzon. Jar burial is practised among the interior tribes of north Borneo. Cave burial occurs in northeast Borneo. Jager wrote of cave burials in the Bisayas and H. Ling Roth discusses the subject quite thoroughly as relating to north Borneo.

The following table gives the measurements obtained by the writer. They are subject to correction by a more experienced observer:

Serial No.	Cephalic Ind.	Nasal Ind.	Orbital Ind.	Height	Capacity
1	77.0	53.5	88.6	138.5 mm.	1,400 cc.
2	75.2	50.0	90.0	140.5	1,420
3	93.7	Not obtainable	94.7	129.5	1,280
4	80.2	52.7	97.0	133.5	1,280
5	91.3	Not obtainable	86.4	127.5	Broken
6	93.7	57.1	84.2	120.0	Broken
7	100.	Not obtainable	87.2	132.0	1,160

As may be seen by the above tables, the skulls were not of a uniform type, but ranged from dolichocephalic to brachycephalic. This corresponds with results obtained by other observers in Malaysia and serves to confirm what is known from other sources, viz.: that the Filipinos, as all Malayans, are very much of a mixture approximating the Japanese, Mongolian and Negritos in certain measurements.

These skulls are quite similar to living types in the neighborhood of their collection. Several of the skulls have been artificially deformed evidently by means of the "tadal" which was in use among the Milanaus of the Bintula River until recently. Jager secured deformed skulls from caves near Samar and Dr. Virchow measured and discussed them. The area of deformation seems to have included Sumatra (Rejang district), north Borneo, Ulitea Island and a part of the Bisayan group, especially Bohol and the Leyte-Samar district.

Race in the Pacific Area with Special Reference to the Origin of the American Indians: 1. Antiquity of Occupation: GEORGE GRANT MACCURDY.

The Pacific washes the shores of both the Old World and the New; hence the Pacific area is a large one. It is at least indirectly in connection with the birthplace of man, for it is accessible from all the great land masses. Whether the American or Asiatic portion of this area was first occupied by man is a question of wide interest. An answer to this question would be of help in locating the spot, if indeed it was a single one, from which man has spread over the face of the earth.

Physically man is a vertebrate and belongs to the great class of so-called Mammalia. We may differentiate still further and place man in one of the Families composing the order of Primates, which includes not only the Simiidæ, but also the lemurs. Eocene lemurs are found in both the western (Puerco beds of North America) and eastern hemispheres. The Simiidæ, however, the family most nearly approaching man in physical structure, all belong to the Old World; the gorilla and chim-

panzee, to Africa, and the orang and gibbon to the Far East. The presumption is strong, therefore, that the human race also originated in the Old World.

To the Pacific area belong the well-known fossil ape-man from Java, *Pithecanthropus erectus*, which according to the associated fauna and flora is of lower Pleistocene age.

The Selenka Trinil Expedition of 1907–08, one of whose results was to reduce the age of *Pithecanthropus* remains from Pliocene to lower Pleistocene, secured a tooth that is said by Dr. Walkoff to be definitely human. It is a third lower molar found not at the Trinil site, but in a neighboring stream bed and in deposits older (Pliocene) than those in which *Pithecanthropus* occurred. Should this prove to be the case, *Pithecanthropus* could no longer be regarded as a precursor of man; it would give us instead the cross section of a different limb of the Primate tree from the limb whose branches represent the various types of Hominidæ.

The principal event of the Australian meetings of the British Association for the Advancement of Science one year ago was the presentation of a fossilized human skull from Darling Downs on the border between New South Wales and Queensland. Unfortunately this specimen was not found *in situ;* but is in the same state of fossilization as are the remains of extinct animal species from the same locality. The latter are said to be of Pleistocene age. The "solidly fossilized" human skull (that of a youth) is evidently not of Neandertal type; nevertheless the authorities present were of the opinion that it represents an extremely primitive type. When archeologists become thoroughly awake to the possibilities of China a new chapter in the antiquity of occupation of the Pacific area will in all probability be recorded.

Passing to the American Pacific shores a good deal has already been accomplished especially in California; but the results do not point to a great antiquity of occupation. Man probably entered the Americas by way of Bering Strait after the final retreat of the last maximum glaciation. Bearing directly on this point is the discovery in 1912 by Dr. Hrdlička of vestiges of an ancient population in northeastern Asia persisting there perhaps since late Paleolithic times, and which possibly gave rise to the American Indian. This is in line with the results of the Jesup North Pacific Expedition, and future archeological discoveries may confidently be expected to support the same point of view. As a seat of human occupation, therefore, China probably antedates Mexico and Peru.

Antiquity of Man in California from the Point of View of the Paleontologist: JOHN C. MERRIAM.

In working over the collections of the state geological survey of California in 1894, the writer's attention was particularly attracted by a collection of mortars and other objects of human manufacture, which, according to the accompanying labels, had been found in the Pleistocene gold-bearing gravels of California. Accompanying these collections were other objects of a similar nature reported by reputable observers to have been obtained in formations not younger than Pleistocene. Although the objects in question were not unlike implements manufactured by the Indians of California within very recent time, the evidence favoring their antiquity appeared so remarkably definite that it seemed worth while attempting to secure all the facts bearing on the question of the occurrence and age in order to obtain some explanation of the evident inconsistency. Numerous inquiries among intelligent observers of good repute regarding the occurrences of human remains and relics in the auriferous gravels of California brought out a considerable amount of information as to the finds already known, and added several important occurrences to the list available. At this time there were known to the writer not less than eleven cases in which, from the point of view of the unprejudiced observer there seemed no question but that artificially fashioned objects had been found to be original constituents of Pleistocene or earlier formation of the California region.

The plan of work thus outlined was beginning to furnish small results when the organization of the department of anthropology at the University of California, through the generosity of Mrs. Phoebe A. Hearst, made it possible to carry out the whole scheme of investigation, only a small portion of which it had seemed possible for the writer to undertake individually up to that time.

While it is evident that the human race did not originate in America, its occupation of the western hemisphere has apparently covered a long period measured in years, if it does not actually extend back to an earlier geological period. At any rate, the advent of man far antedated the beginning of the American historic period and the approximate determination of the date of his arrival, whenever it may have occurred, furnishes an important field for investigation in American history.

As a field for investigation of geologically ancient types of the human race, North America has been notably barren. Even those who have been convinced that man was present on this continent before the beginning of the present geological period must concede that the evidences of his existence are much less common here than in most parts of the Old World.

Of the several widely known discoveries of human remains and relics reputed to represent a geologically ancient type of man on this continent, some of the occurrences reported from California have most persistently forced themselves on the attention of the investigator, though not always receiving general recognition as of scientific value.

It has been realized at the outset that any satisfactory conclusions in a work of this character are not to be arrived at within narrow time limits, and that no single mode of attack may be considered sufficient in itself. At the outset four lines of investigation were laid down: (1) Tracing man back from the known type to the unknown, through an investigation of the great shell mounds of the coast region, the most critical study being given to the lowest or earliest deposits. In this work we go from the known culture of the uppermost layers of the mounds back to a period in which conditions were quite different from those under which the recent Indians appear to have lived. (2) The thorough investigation of all cave deposits, whether recent or Quaternary, with particular reference to possible human occupation. (3) A careful study of these Quaternary or recent alluvial formations in which the occurrence of human remains or relics appears to be possible. This comprised a study of many Quaternary formations and the collection in them of all obtainable fossil remains. (4) A careful review of all the evidence relating to the reputed occurrence of implements or human remains in the Auriferous gravels, or other ancient deposits of a similar nature in California.

The result of investigations along the various lines followed in the original plan for the department of anthropology has shown that in a considerable number of cases fragmentary human remains or fragments of stone and bone worked by man have been found in association with Pleistocene deposits in California, but that in every case a very considerable doubt attaches to the occurrence, so that in no instance do we have in California an undoubted occurrence either of human bones or of implements made by man in such association with Pleistocene deposits as to prove the Pleistocene age of the human relics. While remains of man are known in many localities of undoubted Pleistocene age in the Old World, and while an age in years amounting to many tens of thousands and perhaps many hundreds of thousand years can be ascribed to these remains, we have yet to show in California the relics of man's occupation dating back to more than ten or twenty thousand years.

It is possible that man coming from the Old World, the place of origin of the human race, has at various times colonized the North American continent, but was unable to secure a permanent foot-hold, and because of the brief period of his occupancy has left no ancient relics. Human history may have waited until a comparatively recent time for the occupation of the western hemisphere by man in such force as to make his conquest of the region permanent.

Time Perspective in American Culture, a Study in Methods: EDWARD SAPIR.

A historical science, such as cultural anthropology is, must have chronological perspective. The methods available for the determination of this perspective in aboriginal American culture are partly direct, partly inferential. The simplest type of direct evidence is that contained in the statements of early travelers and noted writers. A second type is embraced in the statements of the natives themselves. The third and most valuable type of direct chronological evidence is obtained by studying the stratigraphy of archeological remains.

The inferential evidence may be derived from the data of physical anthropology, ethnology or linguistics. Conclusions of historical value may be drawn from the persistence of a type in a certain area, and from the denseness of population. Ethnology yields a considerable number of methods for the inferring of time sequences. These may be classed into three groups as the seriation method (*e. g.*, inferences based on the relative degree of development of elements forming a natural sequence); the association method, which can be employed in a considerable number of ways (*e. g.*, by inferring chronological priority of one of two cultural elements because of its entering into a greater number of associations with other elements); and the distribution method. Linguistic evidence may be utilized for the chronology of culture partly by the study of native terms for various culture concepts, partly

by inferences based on the distribution of languages.

The ultimate task of constructing a general picture of the development of culture in America can not be undertaken without the cumulative evidence derived from all possible methods, direct and inferential, for constructing cultural time sequences.

The Zodiacal Basis of the Snake Dance and other Hopi Ceremonials: STANSBURY HAGAR.

The purpose of this paper is to present evidence which tends to show that the ritual of the twelve monthly festivals of the Pueblo Indians of Arizona and New Mexico is based upon zodiacal symbolism, in other words, that the features of each festival refer to the attributes of the native zodiacal signs through which the sun is passing at the time when the festival is held. This interpretation is supported: (1) by the rites directed each month towards one of the twelve white marks distributed around the circular sacred kiva or religious edifice at Zuni, as described by the late Frank Hamilton Cushing; (2) by the association of the sun and star gods as the two principal actors in the winter solstice ceremony at Walpi; (3) by the determination of the moment of beginning the principal ritual of the Manzrau and other festivals at Walpi by observation of the zodiacal constellation in opposition to the sun at the moment of midnight or approximately then; (4) by the repetition of each festival in a minor manner at a date six months distant from the principal performance, the minor festival being directed toward the zodiacal sign in opposition to the sun through the sign. But more impressive than this internal evidence from the writer's viewpoint is the fact that the features of all twelve of the Pueblo festivals *in sequence* correspond with the features of the festival celebrated at the same time amongst the ancient Mexicans and the Maya of Yucatan; and the writer has established at least to his own satisfaction, in papers published in the *American Anthropologist* and the publications of the International Congress of Americanists, that this Mexican and Maya ritual was based upon this same zodiacal symbolism. Such a sequence of symbolism can not be created by chance nor constituted by inauguration. It is revealed in star charts and constellation symbols in the codices, in mural paintings and in the design of sacred cities as well as in the ritual referred to; and if zodiacal in Mexico, the same sequence of symbolism can hardly be otherwise than zodiacal amongst the Pueblos.

Probably in no religion did astronomy play a more important part than in that of ancient America from Peru to Arizona, and this zodiacal symbolism gives us the key to its significance. But in all this vast area only amongst the Pueblos can the astronomic ritual still be seen.

The Snake Dance, to-day the most famous ritual of the American Indian, is but a subordinate episode of the festival which should be known as that of the mountain lion held when the sun is passing through the zodiacal constellation known to the Pueblos, Mexicans and Maya by the name of that animal. It is our sign Leo, the lion. And in the following month the women's Maize Festival of the Pueblos honors the Maize Goddess as in Mexico, Yucatan and Peru when the sun is passing through the sign of the Maize Mother. She is our Virgo, the celestial mother of cereals.

The Octopus Motive in Ancient Chiriquian Art: GEORGE GRANT MACCURDY.

In the ancient pottery of Chiriqui, one soon learns to associate a given motive with a given paste, slip, quality of modeling and the character and number of the colors employed as well as the method of their application. Thus we find the plastic armadillo dominating the great group which might appropriately bear that name; the incised serpent goes with a distinctive group of black ware; the plastic fish in the guise of tripod supports runs through another group; while the painted alligator is supreme in two closely related groups of painted ware. The most puzzling designs were on the so-called lost color ware. A key to their meaning recently came to light in the shape of a more realistic rendering of the motive than had been known hitherto. The design, called to my attention by Professor M. H. Saville, and recently published by me, represents an octopus.

A further study tends not only to confirm what was said in my last note, but also to emphasize the importance of this newly discovered motive as the one distinctive feature of lost color symbolism in ancient Chiriquian art.

On a reexamination of the lost color ware, the octopus design is found to appear unmistakably under one guise or another on perhaps nine tenths of all the lost color vases hitherto published; a cursory study of the large duplicate series in the Yale Museum shows that at least as large a percentage holds true of unpublished specimens. If a new name were needed for this large group, *Octopus* ware would thus be most appropriate.

Eugenics and its Natural Limitations in Man: ALEŠ HRDLIČKA (not present).

Human Eugenics may be defined as the "science of improving the human stock." It stands in many respects on quite a different footing from eugenics of organisms other than man. The term is relatively new; it relates to a seemingly new and most promising as well as timely scope of activities; and due to its appeals to popular imagination, and in common with other newly appearing branches of the science of man in the past, it has been and is now much sinned against. It has been permitted and even used to arouse hopes which at best can not be realized except at a very slow pace and in the course of great length of time.

To improve man it will self-evidently be necessary first to know thoroughly: (1) the stock to be worked upon; and (2) what constitutes improvements in the same; then the worker will be confronted with a most important problem, namely, how to effect the improvements, and how to make them permanent or even progressive, and thoroughly wholesome.

The knowledge of the stock implies perfect anatomical, anthropological, physiological, pathological and especially chemical understanding. How far we are in all these respects from the goal is well appreciated by the more advanced students in these different branches of learning.

As to what would constitute improvement in the human stock a general agreement will probably be reached on the following:

(1) Universal bettering of health;
(2) Fortification against infectious or contagious diseases or immunization;
(3) Elimination of hereditary defects and untoward predispositions;
(4) Increase in nervous power and resistance;
(5) Increase in sensorial efficiency;
(6) Progressive improvement in mentality; and
(7) A general, fixed harmony of all results, that would strengthen and not adversely interfere with the vital functions of the body.

Reflections on the above with our actual knowledge of humanity will readily show the many and great limitations that confront the "science of improving man." We know at best only superficially what we deal with even in the case of our own person; we never learn the whole inheritance of any man or woman; we deal, not with simple mathematical propositions, but with intricate combinations of qualities and quantities in each subject; in a great majority of cases we know not as yet how to remove or compensate for a given defect, or how to strengthen permanently and especially create a desirable quality, or how to prevent or cause the transmission of tendencies or qualities. And we have and shall probably continue to have only insignificant control of subjects in the vital matters of mating, living, environment.

Viewed thus very soberly, the new science in its application to man loses much of its fancied luster; if it succeeds in becoming established as a separate branch of learning, as it has in reference to lower forms, it will be welcomed as a helping sister, confronted with hard work, modest in the appreciation of the difficulties which lie before it and grateful for all past and future assistance. After novelty wears off, it will follow patiently in the slow laborious footpath started upon long ago by the physician and surgeon and then by the students of mankind in general. But it is still somewhat questionable if human eugenics really can prove itself to possess a sufficiency of distinctive attributes to proceed as a separate branch of science.

Migration and Culture: ROBERT H. LOWIE.

Migration and culture are closely interwoven, indeed migration is often solely an inference from cultural facts, especially of a linguistic character. In point of clearly demonstrable migrations the two divisions of the Pacific area differ widely, those of Oceania being incomparably greater than those in western America. Accordingly there has also been a wider diffusion of cultural traits in Oceania. The important problem whether Polynesian seafarers ever reached America remains unsolved. Van Hornbostel has furnished good evidence from the point of view of theoretical music, but this evidence stands alone. There certainly has been no far-reaching influence of Oceania on New World culture.

Ethnologists are beginning to realize that the problem is not solved when similarities in culture are explained by transmission due to contacts. We must learn what particular features are adopted by the borrowing people; whether the borrowed elements are adopted mechanically or are assimilated to the preexisting culture of the people; and a host of other circumstances must be ascertained if our knowledge of cultural diffusion is to become more than superficial. The questions here indicated are among the most promising in the range of ethnology; and Dr. Rivers in England, and a number of American investigators, have made a fair beginning in attacking them.

GEORGE GRANT MACCURDY,
Secretary

SCIENCE

FRIDAY, OCTOBER 22, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

APPLIED CHEMISTRY[1]

IT is only three years ago that a Brooklyn alderman, who, in the absence of the mayor of New York, had to welcome the visitors to the International Congress of Chemistry, addressed them as if they were druggists or pharmacists.

After all, he made not a much greater mistake than many so-called educated men who obtained a B.A. and yet are ignorant enough of elementary scientific knowledge to imagine that the main occupation of a chemist is to analyze substances and detect falsifications.

Even in England, a pharmacist is currently designated as "chemist," while a real chemist is called an "analytical chemist."

But the European war has done much to correct some of these mistaken notions of the public at large. Our daily press has now more or less acquainted this country with the fact that in our national make-up there is such a thing as chemical problems. I doubt, however, whether the unthinking masses have begun to realize that aside of the so-called chemical industry, practically every other industry, in fact, every enterprise, has chemical questions to contend with, and that chemical industry itself is intimately interwoven with the great network of every modern industrial or agricultural state; that the economic welfare of our country and the health of its citizens are largely dependent on the way we utilize our chemical knowledge.

The present war has been aptly called a "chemical war," because efficient work of

[1] An address presented at the meeting of the American Chemical Society, Seattle, Wash.

every department of the fighting armies, from the Red Cross service to the manufacture of guns and explosives, involves incessantly chemical knowledge and—still more chemical knowledge.

But do not imagine that this is the first chemical war: The art of killing and robbing each other became "chemical" the day gunpowder was invented; at that time, however, the existing knowledge of chemistry was just of pinhead size. Napoleon knew very well how to use adroitly exact knowledge and chemistry for furthering his insatiable ambition to dominate the world; so he surrounded himself with the most able chemical advisers and scientists, and, for a while at least, he placed himself at a decided advantage over his many enemies; incidentally, he thus helped to lay the foundation for some very important branches of chemical industry.

"Les chiens ont appris quelquechose," exclaimed the Corsican conqueror when he realized that his enemies began to adopt the same means which had given him temporary mastership over them; but those whom he called so contemptuously "the dogs" finally beat him at his own game.

Ever since then, science, technology and chemistry in particular have played a rôle of increasing importance in the armament of nations. This accounts perhaps for the strange fact that the really great military inventions have practically all emanated from civilians and from non-military nations like our own. If the men of the military class, essentially conservative in all countries, had been left to their own devices, they would probably still be fighting with bows and arrows, or perhaps with the traditional sling. Nor should the pacifist blame the chemist if the latter's most beautiful conquests in science, if his proudest discoveries, have been turned into means of relentless destruction and human slaughter. Do not reproach chemistry with the fact that nitrocellulose, of which the first application was to heal wounds and to advance the art of photography, was stolen away from these ultra-pacific purposes for making smokeless powder and for loading torpedoes. Do not curse the chemist when phenol, which revolutionized surgery, turned from a blessing to humanity into a fearful explosive, after it had been discovered that nitration changes it into picric acid.

As well might you curse written speech or language or the art of printing—by which the most noble thoughts of the human race have been expressed, disseminated and preserved—if it has been used also to distribute the vilest lies and the most damnable errors.

Knowledge is like a knife. In the hands of a well-balanced adult it is an instrument for good of inestimable value; but in the hands of a child, an idiot, a criminal, a drunkard or an insane man, it may cause havoc, misery, suffering and crime.

Science and religion have this in common, that their noble aims, their power for good, have often, with wrong men, deteriorated into a boomerang to the human race. Our very successes will threaten to devour us as long as all of us have not yet become imbued with the truth that greater knowledge, like greater possession of wealth or power, demands a greater feeling of responsibility, greater virtues, higher aims, better men.

Let us hope, in the meantime, that war carried to its modern logical gruesomeness, shorn of all its false glamor, deceptive picturesqueness and rhetorical bombast, exposed in all the nakedness of its nasty horrors, may hurry along the day when we shall be compelled to accept means for avoiding its repetition.

Would you take it amiss if I made a digression from my subject as an answer to repeated attacks which have been made of late by some shortsighted men who blame our increasing scientific knowledge in general and our chemical science in particular, for the excesses of the present European war?

But let us turn our attention to more peaceful chemical pursuits and more particularly to the chemists of this country.

Their work is difficult to understand and still more difficult to be appreciated by the uneducated or uninitiated; nor do chemists court the plaudits of an ignorant public that can not understand them; they feel fully compensated by the results of their work if it only meets with the approval of a few of their fellow chemists, irrespective whether it brings them financial results or not; in fact, most chemists are so much in love with their work that very often they neglect the financial side, to their own immediate detriment.

Unlike the physician, lawyer, clergyman, actor, writer, artist or business man, the chemist does not depend on the public at large; he is either engaged in some private enterprise or he acts in a consulting capacity for a few people, or he is teaching in some educational institution. Popularity in the usual sense has little or no value for the chemist.

No wonder then that the chemists of this country, numerous and active as they are, have hardly been noticed among the daily noise of newspaper sensation and shrieking publicity—no more than a skillful watchmaker would be noticed among the hammering of a busy steam-boiler-manufacturing plant.

And yet, right here in the United States, the chemical profession has taken such a root, such a development during the later years, that our national American Chemical Society, which counts over 7,000 members, has by far the largest membership of any chemical society in the world, with all due respect to England, France and Germany; a society which finds it possible to spend yearly over $100,000 on its three chemical publications, copies of which are to be found all over the world in every well-equipped scientific library. Nor is the study of chemistry in this country a matter of recent occurrence. Our European friends are astonished when we tell them that as far back as 1792, there existed already the Chemical Society of Philadelphia, which was probably the first chemical society ever organized in the world; some of the papers presented at the meetings of that early scientific body furnish even today very interesting reading. Some of our American educational institutions equipped chemical laboratories for students at a time when exceedingly few of the best-known universities possessed any such facilities. In fact, the Rensselaer Polytechnic Institute of Troy, New York, established a chemical laboratory at about the same time as was founded the famous laboratory of Liebig, at the University of Giessen, 1825, and the movement for the establishment of laboratories in the United States was independent of that in Europe.

Nor should we overlook the fact that notwithstanding the essentially pragmatic tendencies of our country, the United States has given to the world a Willard Gibbs, who out-theorized existing chemical theories and whose mathematical deductions are still, after his death, furnishing food for profound thought to the most renowned physical chemists of Europe to whom they have opened entirely new fields in the study of chemical dynamics.

I mention this more particularly for the reason that our aniline-dye-consumers have taken the chemists of the United States

bitterly to task and have made decidedly unfavorable comments upon their abilities, because, since the European war, dyes could no longer be imported from Europe. But Dr. B. C. Hesse, an American-born chemist, a graduate of the University of Michigan, has already ably answered this indictment of the American chemists. In a paper full of information on this subject, which he presented at the New Orleans meeting of the American Chemical Society,[2] but which, unfortunately, has received little or no attention from our daily press, he has clearly demonstrated that the aniline-dye-consumers of the United States can have all the chemists and all the dyes they want; provided they are willing to make the necessary investments of capital and to submit to the risk of uncertain profits by starting their own dye-manufacturing establishments here in the United States instead of, as in the past, favoring imported dyes, either through personal prejudice, or by fostering legislation which forbids the home manufacturers to utilize such methods of selling agreements as "Kartels" or other consolidations of interests; or "dumping," so as to kill new competitors in the field, while making up the temporary loss by increasing the price of other products, and, in general, any of the many other trade-arrangements and trading tricks freely and openly utilized by European manufacturers so as to stifle possible competition of our home aniline-dye-producers.

The outcry which has been raised as to our shortage of artificial dyes is out of all proportion if we take in consideration that the annual importation of dyes and synthetic products from Germany amounts only to about $9,000,000. Mr. A. D. Little, a former president of the American Chemical Society, pointed out[3] that this represents about the same money value as the amount of candy sold annually by the Woolworth ten-cent stores.

The development of any chemical industry is a matter of local opportunities; for instance, the manufacture of cellulose, as well as the industry of wood-distilling, has taken a greater development in the wood-covered sections of the United States than in Germany or any other country in the world.

The magnitude and earning capacity of the largest German chemical enterprises, however imposing they may be, look less important if you take into consideration that some of these companies have been in existence for more than half a century. Much younger American chemical enterprises, which make American specialties—for instance, the Eastman Kodak Company, which sends its films and photographic papers throughout the world—have annual earnings decidedly greater than the most successful German chemical works of much older existence. Nor is the value of the output of some of our largest purely chemical companies much less important than that of the German concerns.

This country is now the greatest producer of sulphuric acid, with an annual production of about 3,000,000 tons. Yet it is not so long ago that the first maker of sulphuric acid had trouble to find purchasers for a triflingly small production of a few tons per week. It needed the opportunity of a home market; by and by this market was created through the refining processes of petroleum after the discovery of our oil fields; the discovery of natural phosphates and the resultant industry of superphosphates; the use of dynamite for blasting; the development of the glucose

[2] See *Journal of Industrial and Engineering Chemistry*, Vol. 7, No. 4, April, 1915, p. 293.

[3] See *Journal of Industrial and Engineering Chemistry*, Vol. 7, No. 3, March, 1915, p. 237.

industry, electrolytic copper refining, etc. These and many newer industries all required large amounts of sulphuric acid and gave this country an opportunity of developing sulphuric-acid manufacturing to its present magnitude. In fact, the same reasoning holds good for all of our industries. I doubt very much whether the talented foreigners, who have now become famous in chemical manufacturing, would have tied their initiative and enterprise by specializing in coal-tar-dyes manufacturing, if they had had the limitless opportunities of an immense undeveloped country like ours, to which to give other outlets to their spirit of pioneership, mining, transportation, agriculture and similar subjects, all beckoning for more urgent attention, and offering at the same time more immediate rewards.

In the meantime some of our other chemical industries, better suited to our local conditions, have taken such an enormous development here as to make the United States an undisputed leader in at least some of them. Such products as the various acids and salts, aluminum, artificial abrasives, calcium-carbide, soda and caustic alkalies, bleaching powder, chlorine products, electrolytic copper, are decidedly more imposing in value and in economic importance than the few million imported coal-tar-dyes.

Mr. F. A. Lidbury, of Niagara Falls,[4] pointed out rightly that if there had been a shortage in some of the products of our electrochemical industries in which the United States has been a pioneer, the consequences to our national economics would have been so serious that the present complaint of our aniline-dye-users would have sounded like a timid whisper, compared with the bellowing lamentations of so many more important industries which would have become absolutely paralyzed. The fact is that few men realize how many industries are directly dependent on the work of American chemists. If the aniline-dye industry has been neglected in this country, there are many good reasons for it; not only was the possibility of reasonable profits too scant to offer special inducement to clever-headed business men for risking their capital in this branch of manufacturing when they had so much better choice in other channels of enterprise, but the first raw material, suitable coal-tar, was not abundantly available here as it is in Europe, for the simple reason that this country long ago discarded the older and more expensive methods of gas manufacturing still generally used in Europe, and which give coal-tar as a by-product. The less expensive and simpler water-gas process, adopted in the United States, gives no suitable gas-tar; it is only of late, by the introduction of the by-product coke-ovens, that we can look forward to an almost illimited supply of coal-tar.

In the meantime, the German manufacturers, while possessing every opportunity and inducement for specializing in these coal-tar industries, could afford to concentrate their efforts so as to supply not only their home consumption and that of the United States, but that of the whole world, in about the same way as the United States sends to the remotest corners of the globe its sewing machines, its typewriters and its Ford cars.

Judging from the past history of the chemical industry in America, I have little doubt that the day it will be found profitable to manufacture all kinds of synthetic dyes here in the United States, instead of a few as is the case now, there will be little further delay in supplying the demand by a hustling and bustling home production.

[4] See *Metallurgical and Chemical Engineering*, Vol. XIII., No. 5, 1915, p. 277.

In fact, it is quite possible that under the present conditions this branch of manufacturing may be stimulated to the point as to result in over-production after the war is over.

If hitherto our chemists have been deficient in this special line, we can, with some satisfaction, point to better efforts in other chemical industries. For instance, it is not sufficiently known how many research chemists in our different American manufacturing establishments are busily occupied in studying and improving manufacturing processes, nor what large sums of money are devoted every year to industrial chemical research. If we hear it constantly repeated that some of the largest German chemical companies have hundreds of chemists and engineers, it is less known that right here in the United States the number of chemists employed in some of our better organized chemical enterprises is scarcely less; but nobody finds it necessary to boast about it. In fact, the most striking symptom is that so many engineering enterprises, for instance, some of our large electrical companies—although their field of action seems rather remote from chemical subjects—have now elaborate chemical research organizations with an excellent record.

Conditions were quite different some fifteen or twenty years ago; but this country has grown, and as the requirements and opportunities grew up new chemical problems arose thereby.

The urgent nature as well as the magnitude of some of these new chemical problems is shaking our chemists awake—is making new men of them.

Professor Whitaker is probably right when he says that from the standpoint of efficiency the chemists are thirty years behind the engineers as far as method and attitude of mind are concerned, but this same criticism holds good for chemists all over the world. The fact is that the engineer was called first, and he was born centuries before the chemist, but the latter is now making up for lost time.

New conditions, new problems, are compelling the chemist to learn to tackle a proposition in a true engineering spirit and —to hitch some business sense to it. He is learning to forget thinking or acting on the test-tube plan; he is thrown more and more in contact with business men; he begins to realize that too one-sided theoretical considerations are sometimes more dangerous than complete ignorance and that a sense of proportion and relative values is the first requirement for good practical effort.

Here, indeed, is one of the weakest spots of the chemist. Aside from the fact that the chemical profession seems one of those vocations which have fascinated a large number of intellectual freaks, it has generally attracted men of an analytical rather than a constructive turn of mind. Successful engineering is essentially constructive. The most urgent work for the chemist of to-day must be constructive—he must learn how to cement together the vast amount of data which already lie at his disposal, even if he himself has to provide some of this very cement by further research.

The chemist of to-day is no longer confined to purely chemical enterprises; even the most stubbornly conservative manufacturers have learned, through competition, that every industry, however mechanical be its nature, has its chemical problems. Things have changed rapidly since the day Andrew Carnegie listened with a sly twinkle in his eyes to the fun his competitors were poking at him when he first engaged a spectacled professor to investigate the chemical problems in his iron-works. Conditions have now become reversed; to-day, a steel or iron works without a com-

petent chemist justly provokes contempt and distrust.

Nor is the time so far distant when even our biggest railroads had not begun to realize how they missed the constant services of a staff of chemists, so as to advise them in the various chemical problems which present themselves in the operation of a well-organized railroad system.

Some time ago, I visited the plant of the National Cash Register Company, in Dayton, Ohio; one of its most interesting departments was its well-equipped chemical laboratory, where no end of chemical questions relating to the manufacture of purely mechanical devices have to be studied and solved. No up-to-date motor-car works is complete without its chemical department and the same remark holds good for all well-organized engineering concerns.

In the United States, the importance of chemistry has been appreciated first in its relation to agriculture. So obvious was this, that we set an example to all other nations of the world by the number and extent of our federal and our state chemical agricultural laboratories. This, more than anything else, was the entering wedge of applied chemistry in this country, which extended, later on, to the government service, the Geological Survey, the Bureau of Standards and the Bureau of Mines. Nor did the useful effect stop there. Many of our federal chemists, our state chemists, have left public service, to accept better paying positions in private industries; but these men trained in public service, implanted their high aims and scientific ways in some of our commercial enterprises, which needed it badly. I know of some cases where this beneficial influence changed radically the whole tone of the commercial organization, from its manufacturing to its selling department, and introduced, instead of reckless, sordid commercialism, a spirit of fairness and efficiency which soon proved the more profitable policy.

In this and similar directions the chemist can exercise a valuable moral influence on the community. If you think it over, you will find that the quest for efficiency lies close to the path of honesty, justice and equity.

Here also the chemist has much to learn. In some instances, I have been astounded at the almost childlike attitude of mind of some of our chemists who are too ready to sell their services to anybody who has a temporary use for them, irrespective of the underlying motives or purposes.

Some lawyers tell me that they never have the slightest difficulty in hiring chemical experts to defend contradictory opinions. For instance, it is quite amazing how some chemists, in their eagerness to please their employers, will overlook their own ignorance of the most elementary principles of patent law, as well as their superficial acquaintance with the many details of intricate technical questions, while not hesitating to furnish cock-sure opinions which encourage infringers or industrial pirates to trespass on the rights of intellectual property of others. Much ruinous patent litigation would be avoided in this country, and invention would be better encouraged, if we had more men of the type of that well-known British electrical expert who never hesitates in court to tell the simple and direct truth, regardless whether it kills or saves the case of his client; his statements are so highly valued and respected that the judges accept them without suspicion, and the same expert is frequently retained by the two opposing parties, whom he serves impartially, and who gladly pay him higher fees than to a mere litigation-acrobat-expert, or a chemical "ambulance-chaser."

The ethics of our profession have been

dealt with by the American Institute of Chemical Engineers, and have been embodied in its recently adopted Code of Ethics, which may furnish a good guide for younger or less experienced chemists. And this leads me to state that many more manufacturers or business men would be induced to utilize the services of chemists if they could feel confident that in so doing they are not putting themselves at the immediate mercy of a stranger, by confiding to him unreservedly facts or processes which it has cost them many sacrifices of time and money to accumulate, and the undivided knowledge of which constitutes sometimes one of their most valuable assets. On the other hand, a chemist can hardly be of any service unless his client or employer is just as frank with him as he would be with his lawyer or physician. However, this mooted point is easily overcome by referring to the Code of Ethics to which I have just alluded, or, better, by making a preliminary agreement between the chemist and his client or employer, safeguarding the interests of both parties. But in such a case, the compensation to the chemist should be made commensurate to the occasion.

This same principle holds good in the employment of chemists in manufacturing plants, where the chemist is either engaged in research or in a manufacturing capacity. An employer should not expect an intelligent chemist to render him important services without proper compensation, and in as far as the practical value of the work of a chemist can seldom be determined in advance, it will pay the employer to offer special inducements or rewards for initiative; he can well afford to give his chemist some share of the increased profits he has received through his work; to do otherwise would be narrow-minded, short-sighted and detrimental to the direct interests of the employer. The work of a research chemist can not be performed nor measured like that of a bookkeeper or a laborer; the results of his work are uncertain; delays and obstacles beset him at every turn; sometimes luck plays an important rôle; but good will, enthusiasm and persistent endeavor are indispensable factors, and these may be encouraged or killed by the attitude of the employer. An employer who is unfair, or who can not arouse the respect or the enthusiasm of his chemists, can not get the best there is in them; he must make them feel that if their work turns out well for him, they will get some fair share of compensation. Therefore, a reasonable salary ought to be supplemented by the possibility of a bonus or some share in the profits based on earnings brought about directly by the work of the chemist.

On the other hand, the chemist must not overlook the financial sacrifices and business-risks assumed by his employer. He should specially bear in mind that knowledge or experience gathered at great cost by his employer, or through expensive factory equipment, or other special facilities, have in most cases enabled him to take up his own part of the work at an advanced stage. It would be rather unfair, unless otherwise stated, that a chemist should be allowed, during or after his period of employment, to divulge or take advantage of all the confidential knowledge or information gathered around the works in which he is employed; or patent for his exclusive benefit any invention he may make on those particular subjects for which he is engaged, as long as the stimulating ideas themselves have been gathered by the very means put at his disposal by his employer. All these questions should be provided for and embodied in an equitable contract which will necessarily vary with special circumstances. But here again, niggardliness, or too great cunning

ness of the employer, will hardly pay. Unless his chemist be a fool—and a fool of a chemist is not worth anything—his employer will lose the good will and confidence of the very man whose work is primarily dependent on these indispensable factors.

Faithful and generous observance of these conditions has brought about the most excellent results in many instances; I know that the contract system, with a salary supplemented by a bonus, or some participation in profits in special departments, has been used with great advantage to all concerned, by some of the most successful chemical companies in continental Europe and in some of the more progressive American enterprises.

It has been objected that a contract of the kind merely binds the employer who has tangible assets, while in most cases it would be difficult to enforce it against faithless employees possessing no property. But even then, a clear and well-defined contract will prevent many misunderstandings which may crop up in the course of time. It has been my experience that direct dishonesty and faithlessness are merely exceptions among chemists, whatever their other shortcomings may be.

We know where the work of the chemist begins. We can never tell where it ends and through what unexpected ramifications it may lead. It is just this fact which adds some zest to the life of the struggling, hard-working chemist, and brings to his work frequently as much excitement as the best of sports; his hopes and disappointments can be compared to those of the restless prospector.

Pasteur, while he was professor at the University of Lille, was consulted by a local alcohol distiller about some irregularities in the fermentation processes. Little did the great French chemist dream, when he tried to solve this seemingly trifling industrial problem, that by doing so he was going to lay bare such an amount of new and unsuspected scientific facts destined to upset all formerly accepted notions, not merely on fermentation, but on life, disease, contagion and epidemics; that he was about to revolutionize surgery, sanitation and medicine, and create several new departments of medical science; that he was going to save millions of lives—reduce sorrow and misery. So little were the men of that period prepared for all these stupendous revelations that this great benefactor of the human race had to suffer most from the gibes and violent attacks of some of the best known men of that very medical profession into which he was going to infuse new life by placing it on a true scientific basis. The history of the stubborn polemics and angry discussions at the French Academy show that, at that time at least, the imagination even of men of science, could not expand to the point of perceiving that medicine and surgery were to be remodeled by a mere chemist.

L. H. BAEKELAND

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES

THERE were last year conferred 556 degrees of doctor of philosophy or science by institutions competent to confer these degrees. This number exceeds the number for last year by 10 per cent., and is double the average number for the decennium beginning in 1898, when these records were begun. During that decennium seven institutions conferred 2,045 degrees and the remaining 38 institutions 685 degrees. The seven institutions still lead decisively, but not to the same extent, and their grouping has been altered. In the first period, Chicago, Harvard, Columbia, Yale and Johns Hopkins each conferred an average of over 30 degrees, while the number at Pennsylvania and Cornell was in the neighborhood of 20. In the course of later years Columbia has surpassed Chicago, and Harvard has not kept equal with these two universities. Yale and Johns Hopkins have remained about stationary

and now are grouped with Pennsylvania and Cornell.

The most notable change has been the increase of advanced work in the state universities. As American students formerly went to Germany for graduate work, so for a period of years students from the central and western states came to the privately endowed eastern universities. They still do so, but the state universities now provide men and equipment making it possible to carry on research work to advantage. Last year Michigan, Illinois, California and Wisconsin each conferred over twenty degrees as compared with an average under five in the earlier period. Iowa, Nebraska and Indiana each conferred six degrees this year.

Of the 556 degrees 309 were in the natural and exact sciences, which represents a relative gain in them over the earlier period during which they were responsible for less than half of the degrees. Chemistry, as always, leads, the 85 degrees being by far the largest number conferred in any subject. Among the sciences botany and geology ranked high this year and appear to be the sciences making the most rapid gains. Botany and zoology followed chemistry and about equalled English and history.

Of 79 degrees conferred by Chicago, 53 were in the sciences; of 70 degrees conferred by Columbia, 27 were in the sciences. At Columbia and Pennsylvania 39 per cent. of all degrees have been in the sciences, at Johns Hopkins it has been 60 and at Cornell 70 per cent.

The institutions which conferred two or more degrees in a science are: *chemistry*, Columbia, 12; Johns Hopkins, 11; Chicago, 9; Yale, 8; Harvard and Illinois, 6 each; California, 5; Cornell and Pittsburgh, 4 each; Michigan, 3; Iowa, Massachusetts Institute of Technology, Minnesota, North Carolina, Pennsylvania and Stanford, 2 each; in *physics*, Harvard, 5; Cornell, 4; Chicago, Clark and Michigan, 3 each; California, Johns Hopkins, Pennsylvania, Princeton and Yale, 2 each; in *zoology*, Columbia, 5; Chicago and Harvard, 4 each; California and Wisconsin, 3 each; George Washington, Illinois, Johns Hopkins and Yale, 2 each; in *botany*, Chicago, 8; Cornell, 7; Washington, 5; California, Johns Hopkins and Pennsylvania, 3 each; Harvard, Illinois, Michigan and Nebraska, 2 each; in *psychology*, Clark, 7; Harvard, 4; Chicago, 3; Michigan, 2; in *mathematics*, Chicago, 7; Harvard, 3; Columbia, Cornell, Pennsylvania and Yale, 2 each; in *geology*, Chicago, 8; Harvard, 4; Columbia, Johns Hopkins and Wisconsin, 3 each; Indiana and Yale, 2 each; in *physiology*, Yale, 3; Chicago and Harvard, 2 each; in *agriculture*, Cornell, 5; Illinois, 4; in *astronomy*, Chicago, 3; Michigan, 2; in *bacteriology*, Brown, 4; in *anthropology*, Columbia, 3; Harvard, 2; in *anatomy*, Minnesota, 2; in *paleontology*, California, 2; in *pathology*, Chicago, 2; in *geography*, Chicago, 3.

TABLE I

Doctorates Conferred

	Average of 10 Years 1898–1907	'08	'09	'10	'11	'12	'13	'14	'15	Total 18 Years 1898–1915
Columbia	32.2	55	59	44	75	81	66	63	70	835
Chicago	35.6	54	38	42	55	57	46	61	79	788
Harvard	33.8	42	38	35	42	41	52	63	58	709
Yale	31.8	32	44	27	31	31	39	32	36	590
Johns Hopkins	30.5	28	27	23	28	32	32	30	31	536
Pennsylvania	22.5	32	29	26	29	34	31	18	34	458
Cornell	18.1	22	34	35	34	33	35	47	31	452
Wisconsin	8.6	17	16	18	23	27	19	31	21	258
New York	6.7	15	13	11	17	10	16	19	15	183
Clark	8.7	11	9	14	16	6	16	9	12	180
Michigan	6.9	4	13	7	6	11	15	7	26	158
Illinois	.5	5	4	12	11	20	20	22	23	122
California	3.3	4	10	6	6	15	10	14	22	120
Boston	4.4	11	13	6	13	8	9	5	9	118
Princeton	2.6	6	4	8	9	12	13	21	12	111
Bryn Mawr	2.1	4	2	5	5	9	3	7	2	58
George Washington	2.8	3	4	4	5	2	2	5	5	58
Brown	2.3	2	5	1	4	6	1	5	7	54
Virginia	2.8	4	1	4	2	4	4	3	2	52
Catholic	2.0	1	3	3	5	5	3	1	9	50
Minnesota	2.4	3	5	1	2	2	3	3	5	48
Stanford	1.4	2	3	5	4	4	5	5	5	47
Iowa	1.1	2	0	4	3	7	3	4	6	40
Nebraska	2.0	2	2	1	0	3	2	3	6	39
Indiana	.0	3	3	0	2	4	3	4	6	25
Radcliffe	.6	1	2	4	0	2	6	2	1	24
Mass. Inst. Tech.	.3	3	0	3	2	6	1	2	2	22
Washington	.7	1	0	0	2	1	3	1	5	20
Cincinnati	.3	0	2	2	5	3	2	2	0	19
Pittsburgh	.1	4	0	2	1	1	5	1	4	19
Missouri	.4	3	0	2	2	1	1	2	2	17
Ohio	.4	0	2	0	2	5	1	2	1	17
Vanderbilt	.6	1	1	2	0	1	2	0	1	14
Georgetown	1.0	0	0	0	0	0	0	1	1	12
N. Carolina	.5	0	1	0	0	0	0	3	2	11
Syracuse	.2	0	2	1	2	0	0	2	1	10
Colorado	.5	0	1	0	0	0	1	2	0	9
Northwestern	.4	0	1	0	1	0	0	0	3	9
Kansas	.3	0	0	3	1	0	0	0	0	7
Tufts	.5	0	0	1	0	0	0	0	0	6
Wash. and Lee	.4	1	0	0	0	0	0	0	0	5
Lafayette	.3	0	0	0	0	0	0	0	0	3
Tulane	.1	0	0	0	0	0	1	0	1	3
Dartmouth	.1	1	0	0	0	0	0	0	0	2
Lehigh	.2	0	0	0	0	0	0	0	0	2
Total	273.0	379	391	362	445	484	471	502	556	6,320

TABLE II

Doctorates Conferred in the Sciences

	Average of 10 Years 1898–1907	'08	'09	'10	'11	'12	'13	'14	'15	Total	Per Cent.
Chicago	16.4	37	20	24	35	37	16	28	53	414	53
Columbia	13.4	21	23	11	29	36	27	21	27	329	39
Johns Hopkins	16.8	17	20	15	19	23	21	18	23	324	60
Cornell	10.4	15	24	27	27	28	30	36	26	317	70
Harvard	14.1	13	14	10	20	15	22	28	33	296	42
Yale	12.4	16	27	12	15	21	19	13	20	267	45
Pennsylvania	9.0	18	13	12	10	9	9	5	11	177	39
Clark	7.7	11	8	14	16	6	13	7	10	162	90
Wisconsin	2.8	6	4	13	13	14	5	17	8	108	42
California	2.4	2	6	4	5	12	9	11	16	89	74
Illinois	.3	0	2	9	6	15	11	18	17	81	66
Michigan	2.8	1	5	1	3	8	10	5	15	76	48
Princeton	1.1	3	3	2	5	7	7	7	4	49	44
Geo. Wash't'n	1.7	2	2	3	4	2	1	2	4	37	64
Brown	1.2	2	2	1	3	4	1	4	5	34	63
Stanford	1.1	2	2	1	4	3	5	2	2	32	69
Minnesota	.7	1	2	1	2	2	2	3	4	24	50
Nebraska	1.3	1	2	1	0	0	2	1	3	23	59
Mass. Inst.	.3	3	0	3	2	6	1	2	2	22	100
New York	.6	1	3	2	1	2	3	1	3	22	12
Indiana	.0	3	3	0	2	4	1	2	4	20	80
Virginia	1.1	2	0	1	1	2	2	1	0	20	38
Washington	.7	1	0	0	2	1	3	1	5	20	100
Bryn Mawr	1.0	1	0	2	1	3	0	2	0	19	33
Iowa	.7	0	0	2	1	3	2	2	2	19	48
Ohio	.4	0	2	0	2	5	0	0	1	14	82
Cincinnati	.1	0	1	1	4	1	2	2	0	12	63
Missouri	.3	2	0	2	2	0	1	1	1	12	71
Pittsburgh	.0	0	0	1	1	1	5	0	4	12	63
Catholic	.5	—	2	0	1	1	0	0	2	11	22
Kansas	.3	0	0	3	1	0	0	0	0	7	100
N. Carolina	.3	0	1	0	0	0	0	1	2	7	64
Vanderbilt	.3	1	1	0	0	1	1	0	0	7	50
Boston	.1	0	1	0	0	1	2	0	0	5	4
Northwestern	.2	0	1	0	1	0	0	0	1	5	56
Tufts	.5	0	0	0	0	0	0	0	0	5	83
Wash. & Lee	.3	1	0	0	0	0	0	0	0	4	80
Syracuse	.1	0	0	1	1	0	0	0	0	3	30
Colorado	.2	0	0	0	0	0	0	0	0	2	22
Dartmouth	.1	1	0	0	0	0	0	0	0	2	100
Lehigh	.2	0	0	0	0	0	0	0	0	2	100
Tulane	.0	0	0	0	0	0	1	0	1	2	67
Georgetown	.1	0	0	0	0	0	0	0	0	1	50
Lafayette	.1	0	0	0	0	0	0	0	0	1	33
Radcliffe	.0	0	0	1	0	0	0	0	0	1	4
Total	124.1	184	194	180	239	273	234	241	309	3,095	49

TABLE III

Doctorates Distributed According to Subjects

	Average of 10 Years 1898–1907	'08	'09	'10	'11	'12	'13	'14	'15	Total
Chemistry	32.3	54	43	48	68	78	68	71	85	838
Physics	15.5	22	25	25	33	30	22	23	31	366
Zoology	15.2	25	18	25	25	20	26	25	32	348
Botany	12.6	11	16	10	20	30	28	34	40	315
Psychology	13.5	23	21	20	23	29	24	12	22	309
Mathematics	12.1	23	14	23	25	22	21	25	23	297
Geology	7.1	5	13	10	15	23	14	13	26	190
Physiology	4.1	7	13	4	2	12	2	8	8	97
Agriculture	1.0	2	7	4	11	11	8	9	9	71
Astronomy	3.4	1	7	3	4	2	11	2	7	71
Bacteriology	1.4	1	5	1	4	6	3	6	4	44
Anthropology	1.0	4	4	2	2	0	3	2	6	33
Anatomy	.9	2	0	1	1	6	1	2	5	27
Paleontology	1.6	1	0	2	0	0	0	4	2	25
Engineering	.8	0	0	1	2	2	0	4	2	19
Pathology	.5	2	3	1	1	2	2	1	2	19
Mineralogy	.6	0	3	0	1	0	0	0	1	11
Geography	.1	1	1	0	1	0	1	0	3	8
Metallurgy	.3	0	1	0	1	0	0	0	1	6
Meteorology	.1	0	0	0	0	0	0	0	0	1
Total	124.1	184	194	180	239	273	234	241	309	3,095
English		30	28	32	35	32	42	42	38	279
History		32	22	25	28	20	26	36	34	223
Economics		17	42	7	17	26	16	27	22	174
Philosophy		25	15	20	26	15	22	19	25	167
Education		6	9	18	28	21	25	27	26	150
German		14	14	16	8	15	23	23	23	136
Latin		13	12	16	13	17	19	16	15	121
Sociology		6	6	14	18	12	11	22	16	105
Romance		12	16	6	12	15	9	15	7	92
Political Science		9	4	9	6	9	15	7	11	70
Oriental		9	15	11	1	10	8	2	10	66
Greek		13	11	5	7	5	8	10	5	64
Theology		7	2	1	7	7	6	8	8	46
Philol. and Comp. Lit.		0	1	5	1	2	4	2	0	15
Law		1	0	1	2	1	1	3	2	11
Classical Archeology		0	0	0	1	3	1	1	4	10
Fine Arts		0	0	0	0	1	1	1	1	4
Music		1	0	1	1	0	0	0	0	3
Total		195	197	182	206	211	237	261	247	1,736

The names of those on whom the degree was conferred in the natural and exact sciences, with the subjects of their theses, are as follows:

UNIVERSITY OF CHICAGO

Hanna Caroline Aase: "Vascular Anatomy of the 'Megasporophyll' in Conifers."

Edward Moore Jackson Burwash: "The Geology of Vancouver and Its Surroundings."

Joseph Stuart Caldwell: "A Study of the Effects of certain Antagonistic Solutions upon the Growth of Zea mays."

John William Campbell: "Periodic Solutions of the Problem of Three Bodies in Three Dimensions."

Joel Ernest Carman: "The Pleistocene Geology of Northwestern Iowa."

Elizabeth Caroline Crosby: "The Telencephalon of Alligator Mississippiensis."

Hermann Bacher Deutsch: "Effect of Light upon the Germination of the Spores of the True Ferns."

Charles Ross Dines: "Functions of Positive Type and Related Topics in General Analysis."

Ellsworth Faris: "The Psychology of Punishment."

Mary Louise Foster: "Studies on a Method for the Quantitative Estimation of Certain Groups in Phospholipins."

Meyer Grupp Gaba: "A Set of Postulates for General Projective Geometry of 'n' Dimensions."

Walter Lee Gaines: "A Contribution to the Physiology of Lactation."

James Frederick Groves: "Life Duration of Seeds."

Olive Clio Hazlett: "On the Classification and

Invariantive Characterization of Nilpotent Algebras."

Oscar Fred Hedenburg: "On the Esters, as well as the Monomolecular B- and γ-Lactones of d-Mannonic and d-Gluconic Acids; On Ortho-Bis-d-Galactonic Acid, d-Galactonic γ-Lactone and Its Mono-Hydrate."

Lewis Victor Heilbrunn: "Studies in Artificial Parthenogenesis: II. Physical Changes in the *Arbacia* Egg."

Albert Edward Hennings: "A Study of the Contact Potentials and Photo-Electric Properties of Metals in Vacuo."

Edwin Frederick Hirsch: "An Experimental Study of the Influence of Iodin and Iodides on the Absorption of Granulation Tissue and Fat-free Tubercle Bacilli."

Louis Allen Hopkins: "On the Theory of the Motion of the Small Planets with a Periodic Orbit for the Hilda Type."

Edmund Charles Humphrey: "Surface Tension at the Interface between Two Liquids."

Andrew Henderson Hutchinson: "Fertilization in *Abies balsamea*."

Libbie Henrietta Hyman: "An Analysis of the Process of Regeneration in Certain Microdrilous Oligochætes."

Wellington Downing Jones: "Geography of Northern Patagonia."

Frank Craig Jordan: "The Color Changes of Certain Variable Stars of Short Period."

George Frederick Kay: "The Geology and Ore Deposits of Riddle's Quadrangle, Oregon."

Charles Edwin King: "The Origin of the Diastases of the Blood and the Lymph."

Harold Reynolds Kingston: "Metric Properties of Nets of Plane Curves."

Harry Dexter Kitson: "The Scientific Study of the College Student."

Francis LeRoy Landacre: "The Origin of the Cranial Ganglia in *Ameiurus*."

John Yiu-Bong Lee: "The Determination of '*e*' by the Small-Drop Method Using Solid Spheres."

James Henry Lees: "The Geological History of the Des Moines Valley."

Edwin Daniel Leman: "The Relation between the Alpha-Ray Activities and Ranges of Radioactive Substances."

Julian Herman Lewis: "The Absorption of Substances Injected Subcutaneously and the Inhibitory Action of Heterologous Protein Mixtures on Anaphylaxis."

William Vernon Lovitt: "A Type of Singular Points for a Transformation of Three Variables."

Bertha Edith Martin: "Tooth Development in *Dasypus novemcinctus*."

Kirtley Fletcher Mather: "The Fauna of the Morrow Group of Arkansas and Oklahoma."

Agnes Fay Morgan: "I. Viscosities of Various Methyl and Ethyl Imido-benzoates and of the Sodium Salts of Para and Meta Nitrobenzoylchloroamides in Moderately Concentrated Aqueous Solutions. II. The Molecular Rearrangement of Some Triaryl Methylchloroamines."

Roberts Bishop Owen: "The Psychology of Recognition."

Harry Morrill Paine: "The Effects of Salts on the Solubility of Other Salts: I. The Solubility Relations of a Very Soluble Bi-univalent Salt. II. The Ionization of Bi-bivalent Salts."

Almon Ernest Parkins: "The Historical Geography of Detroit."

Harley Martin Plum: "The Extraction and Separation of the Radioactive Constituents of Carnotite."

Vincent Collins Poor: "A Certain Type of Exact Solution of the Equations of Motion of a Viscous Liquid."

Terence Thomas Quirke: "Geology of Espanola District."

Isaiah March Rapp: "Flow of Air through Capillary Tubes."

George Burton Rigg: "Decay and Soil Toxins."

Eva Ormenta Schley: "Physical and Chemical Changes Involved in Geo-presentation and Georeaction."

Luther Crocker Snider: "The Geology and Paleontology of the Mississippian Rocks of Northwestern Oklahoma."

Bert Allen Stagner: "On the Molecular Rearrangements of Triarylmethyl Hydroxylamines."

Eugene Austin Stephenson: "Hydrothermal Alteration of Feldspars."

James Palm Stober: "A Comparative Study of Winter and Summer Leaves of Various Herbs."

Clare Christman Todd: "The Action of Alkaline Hydrogen Peroxide on *d. Galactose*."

Stephen Sargent Visher: "The Geography of South Dakota."

Forbes Bagley Wiley: "Proof of the Finiteness of the Modular Covariants of a System of Binary Forms and Cogredient Points."

HARVARD UNIVERSITY

Frederick Osband Anderegg: I. A Contribution to the Study of the Silver Coulometer. II.

The Activities of Concentrated Chloride Solutions from the Electromotive Forces of Silver Concentration-cells. III. The Investigation of the Electromotive Forces of Concentration-cells involving Alloys of Tin and Cadmium and a Fused Electrolyte.''

Leslie Brainerd Arey: ''The Movements in the Visual Cells and Retinal Pigment of the Lower Vertebrates.''

Edward Payson Bartlett: I. ''A Study of certain Oxidation Potentials.'' II. ''The Compressibility of certain Elements and Compounds.''

James Winfred Bridges: ''An Experimental Study of Decision Types and their Mental Correlates.''

Harold Ernest Burtt: ''Factors Influencing the Arousal of the Primary Visual Memory Image.''

Thorne Martin Carpenter: ''A Comparison of Methods for Determining the Respiratory Exchange in Man.''

William John Crozier: ''Studies on Sensory Stimulation.''

Wilbur Garland Foye: ''The Glamorgan Gabbro Body and its Associated Rocks.''

Robert Gorham Fuller: ''Observations on a Collection of Crania from the Prehistoric Stone Graves of Tennessee.''

Irvine Clifton Gardner: ''Metallic Reflection in the Region of extremely Short Wave Lengths.''

Fred Leslie Grover: ''The Atomic Weight of Lead.''

Frederick Simonds Hammett: ''Uric Acid in Tissues.''

Gorham Waller Harris: ''A Revision of the Atomic Weight of Arsenic and Further Applications of the Method of Floating Equilibrium.''

Miner Ludwig Hartmann: ''I. The Free Energy of the Formation of Silver. II. The Atomic Weight of Cadmium.''

Charles Ruglas Hoover: ''The Atomic Weights of Iron, Carbon and Sulphur.''

Max Mayo Miller: ''A Study of the Hypophysis Cerebri in the Pig.''

William Edmund Milne: ''On the Degree of Convergence of Birkoff's Series.''

Joseph Murdoch: ''The Microscopic Determination of the Opaque Minerals: A Contribution to the Study of Ores.''

Christian Nusbaum: ''Eddy Current and Hysteresis Losses in Iron at High Frequencies.''

Sidney Powers: ''The Acadian Triassic.''

Guilford Bevil Reed: ''Studies in Plant Oxidases.''

William Rees Brebner Robertson: ''Chromosome Studies: I. Taxonomic Relationships shown in the Chromosomes of the Tettigidæ and other Sub-families of Acrididæ: V-shaped Chromosomes and their Significance in Acrididæ, Locustidæ, and Gryllidæ: Chromosomes and Variation. III. Inequalities and Deficiencies in Homologous Chromosomes: their Bearing upon Synapsis and the Loss of Unit Characters.''

Arnold Romberg: ''The Ratio of the Calorie at 73° to that at 20°.''

Paul Earls Sabine: ''The Energy of Photoelectrons as a Function of the Frequency for Light of extremely Short Wave Lengths.''

Ellis William Shuler: ''The Geology of the Walker Mountain Overthrust Block in Southwestern Virginia.''

Francis Briggs Silsbee: ''A Study of the Inductance of Four-terminal Resistance Standards.''

Frederick Henderson Sterns: ''The Archeology of Eastern Nebraska, with special Reference to the Culture of the Rectangular Earth Lodges.''

Edward Chace Tolman: ''Studies in Memory.''

Leonard Thompson Troland: ''Studies of Visual Equilibria.''

David Henry Wenrich: ''The Spermatogenesis of *Phrynotettix magna*, with special Reference to Synapsis and the Individuality of the Chromosomes.''

William Henry Weston, Jr.: ''On the Development of *Thraustotheca*, with a Comparative Examination of *Dictyuchus*.''

Charles Edward Wilder: ''Problems in the Theory of Ordinary Linear Differential Equations with Auxiliary Conditions at more than Two Points.''

Levi Thomas Wilson: ''Conformal Transformation of Curvilinear Angles.''

COLUMBIA UNIVERSITY

Leverett Allen Adams: ''Philogeny of the Jaw-muscles in Recent and Fossil Vertebrates.''

Clive Morris Alexander: ''The Time Factor in making Oil Gas.''

Everend Lester Bruce: ''Geology and Ore Deposits of the Rossland District, B. C.''

Fay-Cooper Cole: ''A Study of Tingrican Folklore.''

Clarke Edwin Davis: ''The Surface Tension of Sulphuric Water Mixtures.''

Pauline Hamilton Dederer: ''Oogenesis in *Philosamia Cynthia*.''

John Smith Dexter: ''The Analysis of a Case of continuous Variation in *Drosophila* by a Study of its Linkage Relations.''

Arthur Donaldson Emmett: "Metabolism Studies of Fatigue, Rest and Recuperation."

Frederick Grosvenor Goodridge: "Bio-chemical Studies of Mercaptan."

Edward Gray Griffin: "Inosite and Pinite and some of their Derivatives."

Herman Karl Haeberlin: "The Idea of Fertilization in the Culture of the Pueblo Indians."

Mildred Albro Hoge: "The Influence of Temperature on the Development of a Mendelian Character."

Samuel L. Hoyt: "Copper Alloys."

Roscoe Raymond Hyde: "Sterility and Fertility in *Drosophila ampelophila*."

Israel Jacob Kligler: "Biochemical Studies and Differentiation of Oval Bacteria with special reference to Dental Caries."

Robert Hamilton Lombard: "The Densities and Degrees of Dissociation of the Saturated Vapors of the Ammonium Halides and the Related Thermal Data."

Alexander Lowy: "The Preparation, Properties and Composition of Silundum."

Melvin Albert Martin: "The Transfer-effects of Practise in Cancellation Tests."

Charles Craig Mook: "A Study of the Morrison Formation."

Dora Estelle Neun: "An Examination of Certain Methods for the Study of Proteolytic Action."

George Adam Pfeiffer: "Contributions to the Conformal Geometry of Analytic Arcs."

Percy Withers Punnett: "A Study of the Products of the Action of Different Amylases."

Caroline Eustis Seely: "Certain Non-linear Integral Equations."

Arthur Percival Tanberg: "Experiments on the Amylase of *Aspergillus Orygal*."

Arthur Waldorf Spittell Thomas: "The Influence of Certain Acids and Salts upon the Activity of Malt Amylase."

Francis Maurice Van Tuyl: "The Origin of Dolomites."

Thomas Talbot Waterman: "The Explanatory Element in the Folk Tales of the North American Indians."

CORNELL UNIVERSITY

Elmer Eugene Barker: "Heredity Studies in the Morning Glory (*Ipomea purpurea*)."

Harry Phillip Brown: "Growth Studies in Forest Trees."

Josephine Nash Curtis: "Duration and the Temporal Judgment."

Alan Estis Flowers: "Viscosity Measurement and a New Viscosimeter."

Harvey Nicholas Gilbert: "The Copper Lakes of Eosin."

Ralph John Gilmore: "Variation in the Attachment of the Pelvic Girdle in *Diemictylus vidiscens*, Rafinesque."

Horace Leonard Howes: "The Fluorescence of Some Frozen Solutions of the Uranyl Salts."

Robert Waldo King: "A Method of Measuring Heat Conductivities."

Millard Alschuler Klein: "Studies in the Drying of Soils."

Carl Edwin Ladd: "Cost Accounts on Some New York Farms for 1912–13."

Ira Elver Lee: "Pressure, Temperature and Concentration Relations in the Systems of Sodium Chloride, Ammonia; Sodium Bromide, Ammonia; and Sodium Iodide, Ammonia."

Leonard Amby Maynard: "The Fixation of Nitrogen by Sweet Clover."

Carleton Friend Miller: "Electrolysis of Certain Inorganic Salts in Liquid Ammonia."

George Adin Osner: "Leaf Smut of Timothy."

James Kemp Plummer: "The Effect of Oxygen and Carbon Dioxide on Nitrification and Ammonification in Soils."

Carleton Elderkin Power: "The Effects of Temperature upon the Phosphorescence of Certain Sulphides."

William Jacob Robbins: "Digestion of Starch by *Penicillium* (*Camembertii*)."

Joseph Rosenbaum: "The Phytophthora Disease of Ginseng. Plant Pathology."

Joseph Rosenbaum: "On Mixed Linear Equations over a Two-Dimensional Region."

Peter Juriaan van der Heyde Schreuder: "The Cape Horse—Its Origin, Breeding and Development in the Union of South Africa."

Constantine Demetry Sherbakoff: "Fusaria of Potatoes."

Ransom Evarts Somers: "Copper Deposits of the Burro Mountains."

Arthur Lee Thompson: "The Cost of Producing Milk on 174 Farms in Delaware Co., N. Y."

Carl Joseph West: "On Certain Formulas for Representing Statistical Data."

James Kennith Wilson: "Physiological Studies of *Bacillus radicola* of Soy Bean (*Sojus max* Piper) and of Factors Influencing Nodule Production."

Peter Irving Wold: "The Hall Effect and Allied Phenomena in Tellurium."

THE JOHNS HOPKINS UNIVERSITY

Walter Hatheral Coolidge: "Osmotic Pressure Measurements of Glucose Solutions at 10° and 20°."

Grace Adelaide Dunn: "A Study of the Development of *Halosaccion Ramentaceum*."

Arthur Feddeman Gorton: "Reflection from, and Transmission through, Rough Surfaces."

James Eugene Levering Holmes: "The Difference in Chemical Behavior of Free and Combined Water as Illustrated by the Saponification of Esters."

Marion Byrd Hopkins: "The Chlorides of Orthosulphobenzoic Acid."

Helen B. Hubbert: "The Effect of Age on Habit Formation in the Albino Rat."

Edward Olson Hulburt: "The Reflecting Power of Metals in the Ultra-violet Region of the Spectrum."

Howard Huntley Lloyd: "A Study of the Conductivity of Certain Organic Acids in Absolute Ethyl Alcohol at 15°, 25° and 35°."

Forman Taylor McLean: "A Preliminary Study of Climatic Conditions in Maryland as Related to the Growth of Soy Bean Seedlings."

Austin Ralph Middleton: "Heritable Variations and the Results of Selection in the Fission Rate of *Stylonychia Pustulata*."

Ellis Miller: "A Study of the Vapor Pressure of Aqueous Solutions of Potassium Chloride by an Improved Static Method."

Richard Nicholas Mullikin: "A Study of the Vapor Pressure of Aqueous Solutions of Mannite by an Improved Static Method."

Amos Sentman Musselman: "Osmotic Pressure Measurements of Glucose Solutions at 30°, 40°, 50° and 60°."

Robert Milton Overbeck: "The Copper Ores of Maryland."

Max G. Paulus: "Radiometric Measurements of the Ionization Constants of Methyl Orange and Phenolphthalein."

Lyde Stuart Pratt: "The Esterification of Benzoic Acid by Mercaptans."

Willis S. Putnam: "I. The Conductivity and Viscosity of Certain Rubidium and Ammonium Salts in Ternary Mixtures of Glycerol, Acetone and Water at 15°, 25° and 35°. II. The Conductivity and Viscosity of Solutions of Binary and Ternary Salts in Formamid."

John Bernard Reeside, Jr.: "The Helderberg and Tonoloway Formations of Central Pennsylvania."

John Wesley Shive: "A Study of Physiological Balance in Nutrient Media Resulting in a Simplified Culture Solution for Plants."

Clarence Piersall Sousley: "Invariants and Covariants of the Cremona Hexahedral Form of the Cubic Surface."

Ruth Jennings Stocking: "Inheritance and Variation in Abnormalities occurring after Conjugation in *Paramecium Caudatum*."

Benjamin Franklin Wallis: "The Geology and Economic Value of the Wapanucka Limestone of Oklahoma."

Charles Watkins: "The Conductivity, Percentage Dissociation and Temperature Coefficients of Some Rather Unusual Salts in Aqueous Solution."

YALE UNIVERSITY

Frederick James Alcock: "The Geology of the Lake Athabaska Region."

Stanley Crittenden Ball: "The Natural History and Embryology of the Rhabdocœle *Paravortex Gemellipara*."

Joseph Sumner Bates: "The Synthesis of Dipeptide-Hydantoins, together with a short study of Michigan Hard-wood Tar."

Emil Jacob Baumann: "The Question of Fat Absorption from the Stomach."

Harold Saxton Burr: "The Effect of the Removal of the Nasal Pits on the Behavior, and on the Development of the Head, of *Amblystoma*."

Isaac Faust Harris: "Chemical and Physiological Studies of the Castor Bean and Soy Bean."

Henry Benjamin Hedrick: "Some Principles and Processes in the Construction of Mathematical Tables."

Byron Murray Hendrix: "Studies in the Physiological Action of Some Protein Derivatives."

Henry Daggett Hooker, Jr.: "Thermotropism and Hydrotropism."

Edward Frederick Kohmann: "The Constitution of Mono- and Dinitrotyrosine, and the Xanthoproteic and Millon's Reactions."

John Milton Miller: "The Effective Resistance and Inductance of Iron and Bimetallic Wires."

Harley Dyer Minnig: "A Method for the Separation of Aluminium from Iron and Beryllium."

Robert Alexander Patterson: "The Structure of the Third Cyanogen Band."

John Henry Reedy: "Anodic Potentials of Silver."

Paul Reece Rider: "An Extension of Bliss's Form of the Problem of the Calculus of Variations, with Applications to the Generalization of Angle."

Blair Saxton: "The Nature of Certain Precipitated Inorganic Colloids."

Walter Moody Scott: "The Hydroxyl Derivatives of Phenylalanine, and their Biochemical Interests."

Raymond Louis Stehle: "The Rôle of the Digestive Glands in the Excretion of Endogenous Uric Acid."

Richard Wrenshall: "Synthesis of α-Amino-δ-Phenylvalerianic Acid."

William Josiah Wright: "Geology of the New Ross Map-Area, with an Introductory Chapter on the Gold-bearing Series and the Granites of Southern Nova Scotia."

UNIVERSITY OF ILLINOIS

Demetrius Ion Andronescu: "The Physiology of the Pollen of *Zea Mays* with Special Regard to Vitality."

Albert John Becker: "The Strength and Stiffness of Steel under Bi-Axial Loading."

William Leonidas Burlison: "Availability of Mineral Phosphates for Plant Nutrition."

Harry Peach Corson: "Manganese in Water Supplies."

Oscar Edward Harder: "Alloys of Chromium, Copper and Nickel."

Joseph Whitney Howard: "The Rearrangement of Alkyl Anilines."

Lloyd Theodore Jones: "An Experimental Verification of the Law of Variation of Mass with Velocity for Cathode Rays."

Oliver Kamm: "The Structure of the Dihydro-B-Naphthoic Acids and the Correlation of Ionization and Structure in Unsaturated Acids."

Wallace Macfarlane: "Solubility of Lime Carbonates in Relation to Their Endurance in Soils."

Harold Hanson Mitchell: "Feeding Experiments on the Substitution of Proteins by Definite Mixtures of Isolated Amino Acids."

Edna Mosher: "A Classification of the Lepidoptera Based on Characters of the Pupa."

Fred Weaver Muncie: "The Effect of Large Applications of Commercial Fertilizers upon Carnations."

George Leo Peltier: "Parasitic Rhizoctonias in America."

George Rutledge: "The Number of Abelian Subgroups of Groups whose Orders are the Powers of Primes."

Minnie Elizabeth Watson: "Studies on Eugregarines Including Descriptions of Seventeen New Species and a Synopsis of the Eugregarine Records from the Myriapoda, Coleoptera and Orthoptera of the World."

Morris Miller Wells: "The Relation of Fishes to Ions in their Natural Environment. I. Reactions and Resistance to Acidity, Alkalinity, and Neutrality. II. Reaction and Resistance to Salts."

Frank Archibald Wyatt: "The Influence of Calcium and Magnesium Compounds on Plant Growth."

UNIVERSITY OF CALIFORNIA

William Lind Argo: "The Potential of the Rubidium Electrode."

Gerald Eyre Kirkwood Branch: "The Free Energy of Formation of Formic Acid."

Oscar Leo Brauer: "The Rate of Conversion of Cinchonine into Cinchotoxine."

John Peter Buwalda: "A New Mammalian Fauna from Miocene Sediments near Tehachapi Pass on the Summit of the southern Sierra Nevada."

Lee Raymond Dice: "Distribution of the Land Vertebrates of southeastern Washington."

Helen Margaret Gilkey: "A Revision of the Tuberales of California."

Richard Morris Holman: "The Orientation of Terrestrial Roots with Particular Reference to the Medium in which they are Grown."

William Noble Lacey: "The Free Energy of Formation of Carbon Oxysulphide."

Seth Barnes Nicholson: "Discovery, Observations and Orbit of the Ninth Satellite of Jupiter."

Earl Leroy Packard: "Faunal Studies in the Cretaceous of the Santa Ana Mountains of Southern California."

Frederick Eugene Pernot: "Alternating and Transient Currents in Coupled Electrical Circuits."

Charles Walter Porter: "Temperature Coefficients and the Effects of Acids, Bases and Neutral Salts in Reaction Velocities of the Triphenylmethane Dyes."

Arthur Herbert Saxer: "The Nature and the Velocity of Migration of the Positive Ions in Flames."

Olive Swezy: "The Kinetonucleus of Flagellates and the Binuclear Theory of Hartmann."

Charlie Woodruff Wilson: "On the Life-history of a Soil Amœba."

Harry Stanley Yates: "The Comparative Histology of Certain California Boletaceæ."

UNIVERSITY OF MICHIGAN

Ernest Franklin Barker: "Selective Radiation from Osmium Filaments."

William Howard Batson: "Acquisition of Skill."

George Herbert Coons: "A Study of the Fac-

tors Involved in the Growth and Pycnidia Formation of *Plenodromus Fusco-Maculans*."

George Morris Curtis: "The Morphology of the Mammalian Seminiferous Tubule."

Floyd Carlton Dockeray: "The Effects of Physical Fatigue upon Mental Efficiency."

Alfred Lynn Ferguson: "Activity and Concentration, Transport Numbers and Boundary Potential."

Chester Hume Forsyth: "Vital and Monetary Losses in the United States Due to Preventable Deaths."

Laurence Hadley: "A Study of ζ Ursæ Majoris."

William Vernor Hoyt: "The Constitution of the Nitro-α-Carbopyrrolic Acids."

Walter Fred Hunt: "The Origin of the Sulphur Deposits of Sicily."

Robert Lee Jickling: "Thiophene Analogs of Triphenyl-methyl."

Carleton Volney Kent: "The Optical Constants of Liquid Alloys."

Adrian John Pieters: "The Relation between Vegetative Vigor and Reproduction in some Saprolegniaceæ."

Daniel Leslie Rich: "Oscillatory Spark Discharges between Unlike Metals."

Will Carl Rufus: "The Spectra of Stars belonging to Class R of the Draper Classification."

UNIVERSITY OF PENNSYLVANIA

William Henry Adolph: "A Study of the Quantitative Methods for Fluorine."

Thomas Rush Alexander, Jr.: "The Quantitative Determination of Chromium."

Krikoris Garabed Bohjelian: "Observation and Reduction of Occultations of Stars by the Moon."

Thomas Darlington Cope: "An Application of the Radiometer to the Measurement of Electric Current."

Ernest William Hawkes: "Skeletal Measurements and Observations on the Point Barrow Eskimo with Comparisons with Other Eskimo Groups."

Louis Kossuth Oppitz: "Optical Constants of the Binary Alloys of Silver with Copper and Platinum."

John Young Pennypacker: "Observations on the Beach Plum: A Study in Plant Variation."

Henry Ferris Price: "Fundamental Regions for Certain Finite Groups in Two Complex Variables."

Lowell Jacob Reed: "Some Fundamental Systems of Formal Modular Invariants and Covariants."

David Walter Steckbeck: "Comparative Histology and Irritability of Sensitive Plants."

Heber Wilkinson Youngken: "The Comparative Morphology, Taxonomy and Distribution of the Myricaceæ of the Eastern United States."

CLARK UNIVERSITY

Charles Lewis Brightman: "Thermo-elastic Relations in Steel in the Region of Recalescence."

Burchard Woodson DeBusk: "The Vital Index in Relation to Development."

Elmer Adna Harrington: "The Dielectric Constant of Aqueous Solutions."

William Henry Hayes: "Religion as a Psychic Factor in Social Development."

Yoshihide Kubo: "Some Aspects of Recent Child Study."

William Thomas Sanger: "A Study of Senescence."

George Samuel Snoddy: "An Analysis of Trial and Error Learning in the Human Subject."

Harold Frederic Stimson: "Elastic Hysteresis in Metal Diaphragms."

Raymond Holder Wheeler: "An Experimental Investigation of the Process of Choosing."

Edward Clinton Wilson: "The Psychology of the Story."

UNIVERSITY OF WISCONSIN

Nathan Fasten: "Gametogenesis in the Crustacea."

Edmund Cecil Harder: "Contact Metamorphism as represented by Various Iron Ore Deposits."

John Nicholas Lowe: "Action of Chemical Stimuli on the Chromatophores of the Brook Trout *Salvelinus fontinalis mitchill*."

Charles August Mann: "Chemistry of San Palmetto Berries."

Howard Edward Pulling: "The Movement of Water in Aerotid Soils."

Elizabeth Anita Smith: "Spermatogenesis of the Dragon Fly *Sympetrum semicinctum* (Say)."

Thomas Leslie Tanton: "The Relative Importance of Meteoric and Magmatic Waters in the Deposition of Certain Primary Ores."

William Lawrence Uglow: "A Study of Methods of Mine Assessments and Valuation."

BROWN UNIVERSITY

Ralph Gibney Hurlin: "The Histogenesis and Distribution of the Connective Tissue Pigmentation of the Silky Fowl."

Benjamin Samuel Levine: "The Removal of Natural Impurities of Cotton Cloth by Action of Bacteria."

Courtland Sawin Mudge: "The Effect of Sterilization on the Sugars of Culture Media."

George Hathorn Smith: "The Parenteral Digestion of Bacterial Protein."

Albert Whitman Sweet: "A Sanitary Survey of the Seekonk River."

WASHINGTON UNIVERSITY

Alva Raymond Davis: "Enzyme Action in the Marine Algæ."

William Harrison Emig: "The Occurrence in Nature of certain Fungi Pathogenic for Man and the Higher Animals."

Joseph Charles Gilman: "Cabbage Yellows and the Relation of Temperature to its Occurrence."

Melvin Clarence Merrill: "The Electrolytic Determination of Exosmosis from the Roots of Plants Subjected to the Action of Various Agents."

Lee Oras Overholts: "Comparative Studies in the Polyporaceæ."

GEORGE WASHINGTON UNIVERSITY

Maurice Crowther Hall: "Nematodes of Rodents."

Samuel Palkin: "Investigation of the Halogen Derivatives of the Pyrazolons and the Determination of Antipyrene in Mixtures."

Joseph Duerson Stout: "Studies of the Functions of the Cerebral Motor Cortex of the Cat."

Charles Henry Tyler Townsend: "Contribution to a Thorough Knowledge of the Muscoid Flies; On the Female-reproductive and Early-stage Characters as indicating Phylogeny and a Basis for Taxonomy, together with a Consideration of Host Relations, General Bionomics and Distribution."

INDIANA UNIVERSITY

Halbert Pleasant Bybee: "The Flood of 1913 in the Lower White River Region of Indiana."

John Benjamin Dutcher: "The Nature of the Explosion Wave in an Electrolytic Gas."

Grover Cleveland Mance: "Power Economy and the Utilization of Waste in the Quarry Industry of Indiana."

Fermen Layton Pickett: "*Arisæma triphyllum*: A Biological Study."

UNIVERSITY OF MINNESOTA

William Fitch Allen: "The Spinal Cord of *Bdellostoma*."

Edwin Baumgartner: "Development of the Liver, Gall Bladder and Hepatic Ducts in *Ambystoma punctatum*."

Morris Joslin Blish: "The Chemical Constitution of Wheat Proteins and Their Relation to Baking 'Strength' in Flour."

Sterling Nelson Temple: "Equilibria in Systems of the Higher Alcohols, Water and Salts."

UNIVERSITY OF PITTSBURGH

Raymond Augustine Dumphy: "Partial Vapor Pressures and Distillation."

Sidney Liebovitz: "Theory of Esterification."

Harold Arthur Morton: "Specific Rotary Power of Organic Substances."

Joshua Chitwood Witt: "Oxidation and Reduction without Addition of Acid."

PRINCETON UNIVERSITY

Albert Arnold Bennett: "An Algebraic Treatment of the Theorem of Closure."

Henry Higgins Lane: "The Correlation between Structure and Function in the Development of the Special Senses of the White Rat."

Horace Hardy Lester: "The Determination of the Work Function, when an Electron Escapes from the Surface of a Hot Body."

Keith Kuenzi Smith: "Negative Thermionic Currents from Tungsten."

UNIVERSITY OF NEBRASKA

Richard Hans Boerker: "Ecological Investigations with Certain Forest Trees."

George Borrowman, Jr.: "The Clays of Nebraska."

Clarence Jerome Elmore: "The Diatoms (Bacillarioireæ) of Nebraska."

NEW YORK UNIVERSITY

Alphonse Andrew Adler: "A Method of Measuring Capillarity at Varying Temperatures."

Frank Owen Amon: "The Effect of Acids on the Solubility of Electrolytes."

John Hudson Ballard: "Some Phases of the Psychology of Puzzle Learning."

CATHOLIC UNIVERSITY

Daniel Da Cruz: "A Contribution to the Life History of *Lilium Tennifolium*."

Othmar Frederick Knapke: "A History of the Theory of Sensation from St. Augustine to St. Thomas."

UNIVERSITY OF IOWA

Edward X. Anderson: "Electrical Conductivity of Certain Salts of Pyridine Solutions."

Perry Avery Bond: "4-nitro-5-methyl-2-sulphobenzoic Acid and some of its Derivatives."

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Frederic Hastings Smyth: "The Potential of the Bismuth Electrode and of Sodium Lead Compounds in Liquid Ammonia Solutions."

Louis Weisberg: "The Equilibrium of the Reaction between Carbon and Ammonia at High Temperatures; a Study of the Free Energy of Dilution of Hydrochloric Acid."

UNIVERSITY OF NORTH CAROLINA

Victor Clyde Edwards: "1-, 4-, 5-, 6-tetrahydroxynaphthalene. I. A New Case of Desmotropy. II. A Series of Bromine Derivatives."

William Lewis Jeffries: "The Function of 'Cooking' Fossil Resins in Varnish Manufacture."

STANFORD UNIVERSITY

Elton Marion Hogg: "Studies on the Passive State of Iron."

Roland Neal: "Colloidal Solutions of Copper Sulphide."

UNIVERSITY OF MISSOURI

Eula Adeline Weeks: "A Symmetrical Generalization of the Theory of Functions."

NORTHWESTERN UNIVERSITY

Siegel Buckborough: "The Structure of Maltose and its Oxidation Products with Alkaline Peroxide of Hydrogen."

OHIO STATE UNIVERSITY

John Bernard Parker: "A Review of North American Bombicini."

TULANE UNIVERSITY

Willard Van Orsdel King: "The Mosquitoes of New Orleans and Vicinity."

THE TRUSTEES OF THE UNIVERSITY OF PENNSYLVANIA ON ACADEMIC FREEDOM

The following resolution was offered by Mr. Wharton Barker at the October meeting of the board of trustees of the University of Pennsylvania, and was unanimously adopted:

Because a university has three duties to perform:

1. To aid students to acquire knowledge of information heretofore gathered.

2. To make investigation in every department of human knowledge without restriction.

3. To cause publication of the result of this investigation both within and without the university:

Resolved, That the trustees of the University of Pennsylvania adopt and declare as an adequate expression of their views and purpose the statement of Thomas H. Huxley upon his installation as rector of Aberdeen University in 1874:

"Universities should be places in which thought is free from all fetters, and in which all sources of knowledge and all aids of learning should be accessible to all comers, without distinction of creed or country, riches or poverty."

The following resolution was offered by Mr. Effingham B. Morris, and was unanimously adopted:

In order to avoid misunderstanding of the position of the university toward freedom of academic opinions, speech, teachings and public discussions, by members of its faculties, this minute is entered upon the records of the board of trustees.

Under the original charter and statutes of the university, the trustees are charged with the duty and responsibility of selecting and appointing fit persons as professors to instruct students. Because of the decision of the board at its last meeting not to renew Dr. Scott Nearing's contract of employment as an assistant professor in the Wharton School—which expired by its terms at the end of the academic year—an assumption has been made and circulated that this action indicated a policy to restrict or to prevent free academic discussion. This belief is unwarranted. Indeed nothing could be further from the truth.

The trustees have not only always recognized fully the right of members of the teaching staff to hold and to give proper expression to individual views upon all questions, but there is not now and never will be the slightest wish on the part of the board or of a single one of the trustees to restrict the broadest latitude of opinions, research and discussion. When individual opinions of members of the teaching staff are expressed in a proper manner, upon proper occasions, and with proper respect for the dignity of their relationship to the university, and their consequent responsibility to the institution, such opinions and utterances are welcomed as indicative of progressive growth—no matter how divergent they may be from current or general beliefs.

It is not only not possible, but most undesirable, for any board of trustees to lay down definite

rules for guidance of members of any teaching staff. It would be a sad commentary upon the noble profession of teaching if any university should think a necessity existed to attempt to do so. If a teacher's own conception of the extent of his responsibility to young students, and his own realization of the importance given to his words by the mere fact that the university has commissioned and trusted him to teach, and has conferred upon him the right to use her name in addressing either students or the public, is not sufficient of itself to impose upon him discretion, dignity, fairness, truth, courtesy, sober-mindedness and consideration for differences of opinion, then manifestly any other form of restraint will be futile.

In order to discharge the duty laid upon the board by the charter, the trustees are required to observe and determine the qualifications of prospective teachers before appointing them as professors. The usual routine is an engagement as an instructor, an advance to an assistant professorship, followed—if justified—by appointment as professor. Dr. Nearing followed this usual course. He was found to have an attractive personality and many good qualities as a teacher. During the entire period of the few years in which he was connected with the university, however, his efforts—although doubtless perfectly sincere—were so constantly and continuously misunderstood by the public and by many parents of students, that much to the regret of the trustees they felt unable to give him the promotion to a professorship which he would otherwise have obtained. The termination of his temporary engagement was therefore absolutely in the line of the duty laid upon the trustees by the charter and in justice to Dr. Nearing himself, who was thus free to employ his talents in fields not circumscribed by either requests or promises to avoid strife and turmoil, which are neither necessary nor desirable accompaniments of the objects for which young men are sent to college by their parents.

When an individual teacher's methods, language and temperament provoke continued and widespread criticism alike from parents of students and from the general public who know him only by his public utterances, the freedom of choice in selection of some other person is a right equally as inherent in the board of trustees legally charged with its exercise by the charter, as is the right of freedom of opinion and thought, and teaching in the faculties. And this duty must be exercised for the good of the university as a whole.

The responsibilities of the governing body of any university as laid down in its charter are not confined to the care of its financial and material necessities. A selection or choice of an individual teacher is in itself no possible foundation for a just charge of restriction of academic freedom of speech, and is, of course, no indication whatever of a purpose to effect changes in the present teaching staff.

An expression of its views on this subject made by the board in a somewhat lighter vein some months ago—which it was hoped and supposed was all that would be necessary—is now reaffirmed. It is accordingly again inserted in the minutes, and in connection with this statement indicates the cordial feelings of friendship, admiration and respect felt by the trustees as a body and individually for the members of the faculties of the University of Pennsylvania, upon whose untiring and efficient labors the welfare of the institution depends.

Adopted by the board, 1913, and now reaffirmed:

"In all universities professors habitually express themselves freely upon questions which interest or divide the community. It could never seriously be suggested in any college or university in this country to stifle or control freedom of thought or expression by professors. In a large teaching staff of several hundred men, such as exists at the University of Pennsylvania, occasional unwise utterances are, of course, inevitable, but they do little harm.

"It is natural for some of the younger teachers to take themselves and their opinions upon current social or economic questions more seriously than is warranted by the extent of their practical experience. It is only the passage of years which leads discreet professors, as well as other workers in the world, to be tolerant of the opinions of other students of life as it exists.

"Infallible wisdom can not be expected to hover continuously over the chairs of all professors, any more than over all board rooms of trustees, or over all newspaper or any other offices. Differences of opinion must always exist. But if sanity and good temper and sober-mindedness are kept in view by all persons concerned—trustees, professors, students and public—there will seldom be any occasion for criticism, and none at all for an outcry on behalf of liberty of opinion and freedom of speech at the University of Pennsylvania."

SCIENTIFIC NOTES AND NEWS

As a memorial to the late Charles E. Bessey, the new biological laboratory, about to

be erected at the University of Nebraska, will be named Bessey Hall.

Henri Fabre, the distinguished French entomologist and author, died on October 11 at Sérignan where he was born in 1823.

Dr. Ray Lyman Wilbur, professor of medicine, has been elected president of Leland Stanford Junior University. He will on January 1 succeed Dr. John Casper Branner who undertook to accept the presidency for a limited period on the retirement of Dr. David Starr Jordan, now chancellor of the university. Dr. Wilbur graduated from the academic department of Stanford University in 1896.

The former students of Professor C.-E. A. Winslow have given a dinner in his honor on the occasion of his entrance into his new position of professor of public health at Yale University.

The Rev. Dr. E. W. Barnes, fellow and tutor of Trinity College, Cambridge, has been appointed to the mastership of the Temple. He is the author of memoirs on Gamma functions, integral functions, linear difference equations and related mathematical subjects.

The prize fellowship for original work published by women offered by the Federation of University Women has been awarded to Miss M. Wheldale, Newnham College, Cambridge.

Dr. H. E. Robertson, director of the department of pathology and bacteriology at the University of Minnesota, has declined an offer to become pathologist of the Murphy clinic of Chicago.

Professor Frederic E. Clements, of the University of Minnesota, and Mrs. Clements, spent the summer again in the west, carrying on further investigations into the relationship of climate and vegetation, for the Carnegie Institution of Washington.

Professor A. L. Kroeber, of the University of California, spent part of last summer among the Zuñi of New Mexico where he secured over nine hundred specimens illustrating their everyday and religious life. He made a detailed study of their system of relations and the terms employed to denote relationship.

A lecture on the subject of "Human Evolution in the Light of Recent Discoveries and its relation to Medicine," was delivered on October 13, by Dr. Ales Hrdlička, before a joint meeting of the Medical Society of the District of Columbia and the Anthropological Society of Washington.

A lecture on "The Production of Electricity by Living Organisms" was given by Professor Ulric Dahlgren before the Franklin Institute of Philadelphia on October 14.

Professor James Dryden, head of the Oregon Agricultural College Poultry department, will address the meeting of the Poultry Breeders' Association, which will be held at the Panama-Pacific Exposition in November next. Professor Dryden's subject will be, "Selecting the Layers."

We learn from *Nature* that Professor J. A. Fleming gave a public introductory lecture at University College, London, on "Science in the War and after the War," on October 6. Other public lectures are as follows: "Photographic Surveying," by Mr. M. T. M. Ormsby; "The History of Tools," by Professor W. M. Flinders Petrie; "Final Causes in Animal Psychology," by Mr. Carveth Read; "The Physiological Action of Light," by Professor W. M. Bayliss; "Steam Turbines," by Mr. W. J. Goudie; "Racial Frontiers in Central and Southeastern Europe," by Professor L. W. Lyde; "An Investigation of the Heating of the House of Commons," by Mr. A. H. Barker; and "The Applications of Electric Heating," by Professor J. A. Fleming.

Mr. R. M. Barrington, the Irish naturalist and ornithologist, died on September 15, at the age of sixty-six years.

Dr. Ugo Schiff, professor of chemistry at Florence, has died at the age of eighty-one years.

Dr. Charles Frederick Holder, the naturalist and author, known for his books on marine zoology and related subjects, died at

his home in Pasadena, Cal., on October 11, aged sixty-four years.

Dr. A. Oppel, professor of anatomy at the University of Halle, has died, aged fifty-three years.

The winter meeting of the American Institute of Chemical Engineers will be held in Baltimore, Md., from January 12 to 15. The date selected is somewhat later than usual because the summer meeting was held late in August instead of in June, as is customary. Baltimore is the center of a considerable number of important chemical industries. Excursions to a number of these will be arranged. The experimental laboratories of the Johns Hopkins University and the Naval Academy at Annapolis, Md., will also be visited. A number of papers on recent and important developments in some of the chemical industries of the United States are being arranged for.

The program of the eleventh lecture course of the Harvey Society, to be given on Saturday evenings at the New York Academy of Medicine, is as follows:

October 16.—Professor C. W. Stiles, Hygienic Laboratory, Washington, D. C. "Recent Studies on School Children, with Special Reference to Hookworm Diseases and Sanitation."

November 6.—Professor A. J. Carlson, University of Chicago. "Recent Contributions to the Physiology of the Stomach."

November 27.—Dr. Eugene F. Du Bois, Cornell University. "The Respiration Calorimeter in Clinical Medicine."

December 18.—Professor Florence R. Sabin, Johns Hopkins University. "The Method of Growth of the Lymphatic System."

January 15.—Dr. Donald D. Van Slyke, The Rockefeller Institute for Medical Research. "The Present Significance of the Amino Acids in Physiology and Pathology."

February 5.—Dr. Hideyo Noguchi, The Rockefeller Institute for Medical Research. "Spirochetes."

February 26.—Professor Warfield T. Longcope, Columbia University. "The Susceptibility of Man to Foreign Proteins."

March 11.—Professor Henry A. Christian, Harvard University. "Some Phases of the Nephritic Problem."

March 25.—Dr. R. T. Woodyatt, University of Chicago. "A Conception of Diabetes."

April 8.—Professor Stanley R. Benedict, Cornell University. "Uric Acid in its relations to Metabolism."

April 29.—Professor William H. Welch, Johns Hopkins University. "Medical Education in the United States."

The following specimens have been stolen from one of the exhibits in the mines building of the Panama-Pacific International Exposition at San Francisco: Rough diamond, 4.39 carats; rough diamond, 0.72 carat; facetted black diamond, 17.99 carats; extremely hard diamond, rudely polished; gold specimen from Transylvania; gold nugget; platinum nugget. Any information leading to the recovery of these specimens may be communicated to Professor A. F. Rogers, Department of Geology, Stanford University, California.

It is stated in *Nature* that on September 23, a fire was discovered in the Technical School buildings, Market Street, Newton Abbot, and although the firemen succeeded in confining the outbreak to one room, much damage was done to the school museum, which included the life-long collection of the late Mr. W. Vicary, of The Priory, Exeter, bequeathed some years ago to his nephew, Mr. W. Vicary, chairman of the governors of the Technical School. The collection was considered to be one of the finest out of London, and many specimens were believed to be unique. It included thousands of specimens of minerals, some being very fine and rare. There were also some fine old flints from Dartmoor, stone implements, and a valuable collection of corals. Specimens from all parts of the world were included in the collection, and many can not be replaced. There was also an extensive collection of butterflies of numerous varieties, and some magnificent examples of sampler work, some dating from the sixteenth century. The massive cases, valued at about £300, were completely destroyed, and it is probable that the bulk of the collection is rendered useless by the great heat. Other things lost are the records of the school from 1868, the year of its

inception, and a collection of photographs, most of which can not be replaced, of people who have been connected with the school.

The work of the San Juan Section of the Harvard Field School of Geology during the past summer included the systematic mapping of the southwest quarter of the Montrose quadrangle, the examination of several mines, and a two weeks' trip through the higher mountains of the range. There were fourteen students who were divided into seven teams. Each team of two men was assigned special areas for which the men were responsible, and the work of the several parties was compiled in an "office" on an office map. This was available for all to study, and thus see the larger problems which the study of the region brought out. Through this careful areal work a training in geologic mapping was obtained, and a foundation laid for an appreciation of the physical history of the San Juan Mountains. The expedition through the high mountains gave the men an opportunity to see and appreciate the remarkable physiographic features of the range, and to observe hundreds of field phenomena of geologic and physiographic significance. The work was carried on under the direction of Professor Wallace W. Atwood, and the party included the following men: Le Baron R. Briggs, Cambridge, Mass.; Norman Bradford, Jr., Newport, R. I.; Edward Condon, Shinnicock Hills, L. I.; John L. Ferguson, Spokane, Wash.; W. W. Kent, Chicago, Ill.; S. E. Peabody, Boston, Mass.; J. K. Selden, N. Andover, Mass.; T. L. Storer, Waltham, Mass.; Robert S. Sturgis, Winnetka, Ill.; W. J. R. Taylor, Rochester, N. Y.; L. Pierson Teas, Philadelphia, Pa.; Lucian B. Walker, Tulsa, Okla.; R. U. Whitney, North Haven, Maine; R. A. Terry, Chicago, Ill.

The American Museum *Journal* states that a rare collection of archeological objects from the Department of Ica, Peru, was recently purchased by Mr. A. D. Juilliard and presented to the museum. This collection represents the results of numerous expeditions during the last nine years by Mr. Manuel Montero to the desert regions to the south and west of Ica. These visits to the prehistoric burial grounds were his vacations, and every object in the collection was excavated by him. The most notable objects are nine large shawl-like garments covered with conventionalized figures in embroidery. The beautiful color schemes seen in these textiles make them a joy to the artist, and they will doubtless be copied eagerly by the numerous art students who make constant use of the museum collections. Besides these shawl-like garments there are many smaller pieces of cloth which are highly ornamented. The metal work of these ancient people is represented by objects in silver and copper. There are several pairs of large silver ear-plugs, ornamented with embossed figures of birds, silver tweezers also ornamented with raised bird figures, and a number of shawl pins with finely executed figures of birds and pumas on the upper ends. The other objects in the collection consist principally of the women's workbaskets, with spindles and various colored threads, a loom with cloth in process of weaving, feather ornaments, slings, musical instruments and a few choice pieces of pottery.

UNIVERSITY AND EDUCATIONAL NEWS

The Vassar jubilee endowment fund has reached $696,000, the gifts of the alumnæ amounting to $221,000.

There is a probability of a merger of the University of Pennsylvania medical school with that of the Medico-Chirurgical College of Philadelphia. If the amalgamation is consummated a great school for post-graduate medical work will be established at the University of Pennsylvania. The present students of the "Medico-Chi" would be transferred to the University Medical School, as well as a number of members of the faculty. Some of the "Medico-Chi" buildings together with large additions would become the headquarters for the postgraduate school.

The work of grading the ground for the new medical school building of the University of Cincinnati directly opposite the Cincinnati General Hospital has begun. The school will

be ready for occupancy in about a year and a half. The cost of the buildings will be about half a million dollars.

The department of pharmacy of the Oregon Agricultural College has been notified of its acceptance as a member of the American Conference of Pharmaceutical Faculties.

The will of the late Mr. George May, mining engineer and colliery proprietor, of Darlington, bequeaths £500 to the North of England Institute of Mining Engineers, the income to be applied in providing "George May" prizes for students, and 500*l.* to Armstrong College, Newcastle, to found a "George May" scholarship in mining.

Professor Herbert Couper Wilson, of Carlton College, has been appointed visiting lecturer in astronomy, at Harvard University. Marshal Fabyan has been promoted to be assistant professor of comparative pathology.

DISCUSSION AND CORRESPONDENCE

PARASITES OF THE MUSKRAT

In a recent number of the *Journal of Parasitology*,[1] Professor Al. Mrázek, professor of zoology, Bohemian University, Prague, called the attention of American helminthologists to the opportunity for study of the parasites of one of the most typical North American mammals.

We announced in a recent number of Science[2] the finding of a varied and abundant parasitic fauna in muskrats in Nebraska and called attention to the important, virgin and fertile nature of this field for the parasitologist and the need and value of a thorough survey of the parasitic fauna of our common North American animals.

A study of the parasites of the muskrats, now practically completed, gives the following data. In forty-two muskrats, 881 parasites were found. No parasites were found in four muskrats, three harbored cestodes, trematodes and nematodes and three harbored a single species of trematode. The parasites found represent nine species of trematodes, of which three belong in the genus *Echinostomum* and one in each of the following genera, *Echinoparyphium*, *Notocotyle*, *Catatropis*, *Plagiorchis*, *Hemistomum*, and a new genus *Wardius*. Two species of cestodes were found belonging in the genera *Hymenolopis* and *Anomotaenia* and three species of nematodes, belonging in the genera *Trichiurus*, *Trichostrongylus* and *Capillaria*. The description of these parasites is given in the June number of the Journal of Parasitology, Vol. 1, No. 4.

Franklin D. Barker
The University of Nebraska

[1] 1914, Vol. No. 2, p. 104.

[2] 1913, Vol. 37, p. 268.

THE CHEMICAL COMPOSITION OF BORNITE

In Science for September 17, 1915, Professor Austin F. Rogers admirably summed up the evidence as to the composition of bornite, and concluded that the best explanation of the known facts is that the mineral consists of a solid solution of varying amounts of chalcocite, Cu_2S, in a normal bornite, Cu_5FeS_4. The object of this note is to bring forward another possible interpretation.

Since chalcocite is of common occurrence as inclusions in bornite the assumption that it may unite with the latter in solid solution is a reasonable one. But inclusions of chalcopyrite, $CuFeS_2$, and even of pyrite, FeS_2, are likewise frequently found, so it can not be denied that these minerals may also form solid solutions in the bornite. The clustering of analysis points in the diagram around Cu_5FeS_4 may then be accepted as "evidence that [normal] bornite has the formula Cu_5FeS_4" without excluding the possibility of solid solution, because the analyses lying in the diagram to the left of the Cu_5FeS_4 point may well be those which contain the chalcopyrite in solid solution, the absence of analyses far to the left of the Cu_3FeS_3 point indicating that this is the limit of solubility of chalcopyrite in bornite: $Cu_5FeS_4 + CuFeS_2 = 2Cu_3FeS_3$. The entrance of pyrite in solid solution would also account at least in part for those analyses lying above the diagonal line, and it need not be assumed that they are erroneous.

There is, however, another way of explaining variability in composition of the type shown

by bornite, which has perhaps not received the attention from mineralogists it deserves. Are we certain that the absence of inclusions of such size as to be visible under the microscope (in this case, the metallographic microscope) necessitates the hypothesis of the existence of solid solution at all? In metallographic study inclusions may be seen to vary more or less continuously from microscopically visible sizes down to the limit of microscopic visibility, which lies in the general neighborhood of 0.001 mm. in diameter. This lower limit is determined by the wave-length of light, and has no significance as far as chemical molecules are concerned. It can therefore not be expected that the variation in the size of inclusions ceases at that particular point; in all probability they also occur of submicroscopic size. Accordingly, as an alternative hypothesis to that of Professor Rogers the writer would suggest that the variability in the composition of bornite (normally Cu_3FeS_3) is due to the presence of submicroscopic inclusions of one or more of the minerals often occurring as visible inclusions in it, namely chalcocite, chalcopyrite and pyrite.

Edgar T. Wherry

U. S. National Museum,
Washington, D. C.

WIND GAPS

Are physiographers unconsciously predisposed in favor of an explanation of topographic phenomena which possesses a dramatic element as against one which, though quite obvious, involves only the operation of causes which are commonplace?

An examination of the explanation given of the formation of wind gaps by writers of American text-books on physical geography and geology would seem to answer this question in the affirmative.

All who treat this topic, so far as I have been able to determine, explain wind gaps—all of them—as deserted water gaps—vestigial structures, as it were, inherited from a certain stage in a past cycle of erosion.[1]

In this explanation all these writers hark back to the original source, the monograph by Bailey Willis on "The Northern Appalachians" (American Book Company, 1895). It is true that the monograph itself refers to earlier sources—to the work of Davis and Hayes and Campbell—but the constancy of reference by these text-book authors to Snickers Gap, cited in the monograph as a type illustration of a wind gap, and the reproduction of the two diagrammatic maps, there first printed as illustrations accompanying the explanation of same, indicate this monograph of Bailey Willis as the true source.

It is not the purpose of this article to detract from the general admirable treatment of mountain structure contained in the above treatise. It is one of the American physiographic classics, replete with that wealth of imagery derived from human activity which so characterizes a writer on physiography of the school of Davis. In that monograph streams now "leap" and now "loiter"; they "ripple over gravel bars" or "linger between alluvial banks"; they commit "piracy" and "conquer their neighbors."

It does seem to the writer, however, that a danger to scientific accuracy lurks in this imagery. An explanation that applies in the vast majority of instances is lost sight of because prosaic.

As a substitute, therefore, for the—beheading—diverting—reversing—stream processes, which must concur in the formation of every wind gap, it would seem, in the view of the writers of the above school of physiography, I would suggest the following:

A wind gap in the vast majority of instances is simply a col in the top of the divide, notched by the retreat of the sources of two

[1] Salisbury and Atwood, "Interpretation of Topographic Maps," p. 51. Salisbury, Atwood, and Barrows, "Text-book on Physiography." Tarr and Martin, "College Physiography," p. 567. Tarr, "New Physiography," p. 104. Hobbs, "Earth Features and Their Meaning," pp. 176, 177. Dryer, "Lessons in Physical Geography," p. 160. Emmerson, "Manual of Physical Geography." Trafton, "Laboratory and Field Exercises in Physical Geography," p. 19. Scott, "An Introduction to Geology," p. 448. Chamberlin and Salisbury, "Geology." Part I., p. 189.

streams which have happened to head opposite each other.

It is one of the commonest phenomena in a maturely dissected region, whether this be mountainous or simply a plateau.

In the Blue Ridge Region covered by Harpers Ferry sheet, there is nothing in the arrangement of the drainage or in the disposition of the contours which would suggest that all of those wind gaps—Snickers, Ashby, Crampton, Turners and a number unnamed—might not be as satisfactorily explained in this way as by a "diversion"—reversion—and "beheading" process. To my mind, the simple notching process affords by far the better explanation, since it fits in with the general and notable characteristic of the topography which militates against the Willis theory. This is the total lack of that "barbing" arrangement in the tributaries of the streams alleged to have been reversed which would seem to be necessary as conclusive evidence that these wind gaps are corollaries resulting from cases of "river piracy."

There is one line of evidence, namely, a progressive deepening of the wind gap notches in the Blue Ridge from the Water Gap of the Potomac at Harpers Ferry southward, which, if this were pronounced enough, might be alleged in support of the "River Capture Theory." However, Professor Willis barely hints at this evidence in calling attention to Manassas Gap—the most remote from the Potomac water gap of the wind gaps in the Blue Ridge south of the Potomac as well as the deepest.

The paragraphs from the Willis monograph which have become the sources of "the accepted text-book theory of wind gap formation" are as follows:

> On the Kittatinny Plain many smaller streams flowed across the ranges; and they also, persisting in their courses during the upheaval, cut water gaps in the hard beds. But they could not deepen the gaps as rapidly as did the great rivers, and the work of the smaller streams is now represented by the notches in the ridges high above the Shenandoah Plain. No streams now flow through these little V's: they are *wind gaps* from which a rivulet descends on each side of the ridge. . . . The Potomac traverses the Blue Ridge at Harpers Ferry. South of this water gap are several wind gaps, such as Snickers Gap, which mark the channels of ancient streams, now diverted. The Shenandoah River enters the Potomac above the water gap at Harpers Ferry, flowing northward along the western base of the Blue Ridge. The streams which passed through Snickers Gap and the other wind gaps ran above the present course of the Shenandoah, crossing it about at right angles. The two drainage systems could not exist at one time; therefore it is evident that the older one has been replaced by the younger river, the Shenandoah. This diversion took place by the gradual growth of the Shenandoah from its mouth southward. The Potomac, the large stream, cut its water gap faster than Snickers Gap was cut. The Young Shenandoah of the Kittatinny Plain, a small tributary of the Potomac where the mouth of the present Shenandoah is, acquired considerable fall as the Potomac deepened its gorge and sawed its channel down rapidly in the limestone, which offered no great resistance. But the stream in Snickers Gap, with perhaps less fall and not much greater volume than the Shenandoah, had to saw much harder rock in crossing the Blue Ridge. Its channel remained high, therefore, as compared with that of the Shenandoah. The latter, extending its headwaters backward as a tree puts out new twigs, eventually tapped the channel of the other stream above Snickers Gap. The waters above the point of attack joined the Shenandoah; the section between the point of attack and Snickers Gap was reversed as the Shenandoah rapidly deepened the channel of its new conquest; and the lower portion of the stream, now called Beaverdam Creek, having lost its original head waters, took its rise at Snickers Gap. Thus the ancient stream which once flowed through the gap was divided into three sections, the diverted, the inverted and the beheaded, while the Shenandoah, the diverter, was strengthened.

Thomas Jefferson, the only one of our presidents, except Roosevelt, who ever showed marked interest in science, also tried his hand at explaining topographic features of the Blue Ridge. It occurs in his notes on Virginia written in 1781, and the passage is as follows:

> The passage of the Potomac through the Blue Ridge is perhaps one of the most stupendous scenes in nature. You stand on a very high point of land. On your right comes up the Shenandoah,

having ranged along the foot of the mountain an hundred miles to seek a vent. On your left approaches the Potomac, in quest of a passage also. In the moment of their juncture they rush together against the mountain, rend it asunder and pass off to the sea.

The first glance of the scene hurries our senses into the opinion that the earth has been created in time, that mountains were formed first, that the rivers began to flow afterwards, that in this place particularly they have been dammed by the Blue Ridge Mountains, and have formed an ocean which filled the whole valley, that continuing to rise they have at length broken over at this spot and have torn the mountains down from the summit to the base.

Probably in the whole realm of literature there does not exist a more striking illustration of the cataclysmic point of view in attempting to explain geological phenomena than is expressed in the above passage, and it serves to illustrate how far in general in the scientific realm we have got away from the catastrophic ideas of Jefferson's day, which antedate even somewhat those of Cuvier and Schlotheim; yet when one examines the literature of modern physiography and sees the readiness with which "an uplifted and dissected peneplain" is invoked to explain every even sky-line or approximate uniformity in heights of mountain summits, while every peculiarity in drainage is accounted for as an inheritance from a past cycle of erosion, overlooking in many cases a simpler explanation involving only "processes now in operation"; he wonders if there does not lurk therein somewhat of the old catastrophism.

Arthur M. Miller
University of Kentucky

SCIENTIFIC BOOKS

Der Nachweiss organischer Verbindungen. Ausgewählte Reaktionen und Verfahren. By Dr. L. Rosenthaler. Verlag von Ferdinand Enke, Stuttgart. 1914. 6 × 9.5 inches. Pp. xvii + 1,070. 35.20 Marks bound.

This work comprises the nineteenth and twentieth volumes of a series of monographs edited under the direction of Dr. B. M. Margosches, and published under the general title "Die Chemische Analyse. Sammlung von Einzeldarstellungen auf dem Gebiete der chemischen, technisch- chemischen, und physikalisch-chemischen Analyse." The earlier volumes are nearly all technical monographs dealing with the various phases of analytical chemistry. In the present volume, however, there has been gathered together an immense amount of general information for the organic chemist.

Everywhere that chemistry is taught there are given courses in inorganic qualitative analysis and text-books and reference works dealing with the separation and identification of inorganic compounds are to be found in every chemist's library. When, however, we pass into the realm of the carbon compounds we find that an entirely different situation obtains. There are but few texts or reference works dealing with the separation and identification of organic compounds, and it is a rare university that lists a course in qualitative organic analysis. This volume by Dr. Rosenthaler should, therefore, receive a hearty welcome from the organic chemist and will undoubtedly stimulate courses in the separation and identification of organic compounds.

In the introductory chapter are given the various qualitative tests for carbon, hydrogen, nitrogen, the halogens, sulfur, phosphorus, arsenic, etc., following which, in succeeding chapters are considered hydrocarbons, alcohols, aldehydes, ketones, carbohydrates, phenols, acids, oxy-acids, aldehyde- and keto-acids, ethers, quinones, esters, halogen derivatives, nitro derivatives, nitriles and iso-nitriles, acid amides, amines, aromatic hydrazines, azo and diazo compounds, acid derivatives of organic bases, heterocyclic bases, amino acids, polypeptides, organic sulphur compounds, organic arsenic compounds, alkaloids, resin acids, tannins, glucosides, saponines, pigments, proteins, enzymes and tox-albumens.

Rosenthaler's scheme of analysis is to first of all determine to which group or groups of compounds the unknown belongs. In order to do this the characteristic reactions of each class mentioned above are given very explicitly.

Then, following the class reactions, are the more common individual compounds, listing in each instance the physical and physiological properties of the compound, the methods for its preparation, the characteristics of its important compounds and derivatives, following which are methods for its identification, and in many instances methods for its separation from other compounds as well as its quantitative estimation. In all there are considerably over 2,500 organic compounds considered in greater or less detail.

The volume closes with a chapter on the preparation of the necessary reagents, followed by a table of melting points arranged in ascending order, this being in turn followed by a boiling point table similarly arranged. The arrangement of the index is decidedly novel. The index of compounds is in tabular form, giving the name of the compound, the page citation, the formula, the molecular weight and the percentage composition. The volume is concluded by an author index to the numerous literature citations.

Organic chemists have long felt the need of such a work, and it will, I am sure, find a hearty welcome. The identification of an organic compound should be relatively simple if this reference work is used as a supplement to Beilstein and Richter's "Lexikon." It is likewise admirably adapted for use as a text in a course of qualitative organic analysis.

ROSS AIKEN GORTNER

Molecular Association. By W. E. S. TURNER. London and New York: Longmans, Green and Co. 1915. Pp. viii + 170. Cloth. $1.40 net.

This is a further contribution to the series of monographs on inorganic and physical chemistry edited by Alexander Findlay. Dr. Turner, with the cooperation of a number of his students, has prepared a praiseworthy contribution to this excellent series of publications. In the nine chapters of the book are given an introduction and a discussion of molecular complexity in gases, dissolved substances, and the liquid state. Special attention is given to "the influence of the solvent" in the case of solutions, also to surface tension, and other methods of measuring molecular complexity of liquids, to the molecular complexity of water and the theory of dynamic allotropy. The selection and use of molecular formulæ, molecular association and physical properties, and molecular association and chemical combination are the subjects of the last three chapters. A long and fairly complete list of references to original literature is given at the end of the book. The appendix contains in tabular form a summary up-to-date of work done on the molecular complexity of dissolved substances. Here also references to original publications are added.

The author evidently regards the various molecular weight determinations in solutions as indicative of the actual molecular weights of the dissolved substances, and does not consider that the "abnormally" high or low molecular weights so frequently observed may quite as well be explained by a species of chemical union between solvent and dissolved substance. Thus it is not surprising that the entire subject of "molecular association and chemical combination" should have received only a step-motherly treatment, but five pages of the monograph being devoted to it.

The book is a compilation and not an original contribution. It will doubtless be useful to the advanced student of physical chemistry, who has thus brought before him in available and readable form the essence of the various important contributions on the subject treated. The author is clearly an enthusiast over the molecular theory, and the student can not but get some of this enthusiasm in perusing the monograph. May this result in further experimentation that shall bring to light more useful knowledge and a better conception of the act of solution as related to chemical combination, on the one hand, and the forces of cohesion and adhesion, on the other hand.

The book is printed on good paper, the typography is excellent, the cuts are well executed, but the binding is unattractive, cheap and not durable in form.

LOUIS KAHLENBERG

SPECIAL ARTICLES

ON THE COEFFICIENT OF CORRELATION AS A MEASURE OF RELATIONSHIP

THE theory of correlation deals with the relationship between variable quantities in the case where that relationship lies somewhere between functional dependence and complete independence. In the case of normal correlation for two variables a certain quantity r, which is zero for complete independence and ± 1 for functional dependence, plays an important rôle. The formula for r, in terms of n observed pairs of values of two variables x and y, is

$$(1)\qquad r=\frac{\sum_{i=1}^{i=n}(x_i-x_0)(y_i-y_0)}{\sqrt{\sum_{i=1}^{i=n}(x_i-x_0)^2\cdot\sum_{i=1}^{i=n}(y_i-y_0)^2}},$$

where x_0 is the mean of the x-values and y_0 the mean of the y-values.[1] This formula has also been given an interpretation for the case of skew correlation[2] which makes r an important quantity in many instances of such correlation.

The quantity r is usually termed the coefficient of correlation and is said to measure the amount of correlation between the variables x and y. This latter statement is too vague as it stands for scientific procedure, so it is desirable to state more precisely what is meant by it. In the case of normal correlation r has been shown to have the following significance:[3] if we take the mean of all the y's corresponding to a given value of x, then the deviation of this mean from the mean of *all* the y's, divided by the standard deviation of the y's, is equal to r times the deviation of the given x-value from the mean of all the x's, divided by the standard deviation of the x's. Thus r may be said to measure the tendency of a given deviation from the mean in one of the variables to be associated with an average deviation from the mean of corresponding magnitude in the other variable.

It is clear that the value of r throws much light on the relationship between two variable quantities in the case of normal correlation. It is not apparent, however, that it gives us in every instance the information we are most interested in obtaining, and it will be shown in what follows, that in certain cases of interest in the applications of the theory of correlation it will not necessarily give it.

The formula (1) is well adapted to the computation of r from observed values of x and y. For our purposes, however, we need a formula which exhibits r as a function of the underlying variable quantities that determine x and y and the relationship between them. We shall now proceed to obtain such a formula on the basis of assumptions similar to those that Pearson used in his derivation of (1).[4]

Let

$$(2)\qquad \begin{aligned} x&=f_1(\epsilon_1,\epsilon_2,\cdots,\epsilon_m),\\ y&=f_2(\epsilon_1,\epsilon_2,\cdots,\epsilon_m),\end{aligned}$$

where the ϵ's are independent variables that follow a Gaussian distribution, and the f's are analytic functions. If we expand the right-hand members of (2) about the mean values of the ϵ's and neglect higher powers than the first,[5] we have

$$(3)\qquad \begin{aligned} x-x_0&=a_{11}\eta_1+a_{12}\eta_2+\cdots+a_{1m}\eta_m,\\ y-y_0&=a_{21}\eta_1+a_{22}\eta_2+\cdots+a_{2m}\eta_m,\end{aligned}$$

where the η's are deviations of the ϵ's from their mean values and x_0 and y_0 are mean values of x and y, respectively.

Since the ϵ's are independent variables following a Gaussian distribution, we have

[1] *Cf.* Pearson, "Regression, Heredity and Panmixia," *Philosophical Transactions of the Royal Society*, 187 *A* (1896); also Bravais, "Analyse mathématique sur les probabilités des erreurs de situation d'un point," Académie des Sciences: Mémoires présentés par divers savants, Sér. 2, Vol. 9 (1846).

[2] *Cf.* Yule, "On the Significance of Bravais's Formulæ for Regression, etc., in the Case of Skew Correlation," *Proceedings of the Royal Society*, Vol. 60 (1897).

[3] *Cf.* Pearson, *l. c.*

[4] *L. c.*

[5] Pearson assumes that the variations of the ϵ's from their mean values are small in comparison with those values, in order to justify the dropping of higher powers. It is more general to assume merely that for the range of values of the ϵ's considered, the f's are sufficiently good approximations to linear functions to warrant the neglect of higher powers.

$$\sum_{v=1}^{v=n} \eta_i^{(v)}\eta_j^{(v)} = 0 \qquad (i \neq j),$$

where

$$(\eta_i', \eta_j'), (\eta_i'', \eta_j''), \cdots, (\eta_i^{(n)}, \eta_j^{(n)})$$

are n pairs of values of η_i and η_j. Hence, substituting in (1) the values of $(x - x_0)$ and $(y - y_0)$ given by (3), we obtain

$$(4) \qquad r = \frac{\sum_{i=1}^{i=m} a_{1i}a_{2i}s_i^2}{\sqrt{\sum_{i=1}^{i=m} a_{1i}^2 s_i^2 \cdot \sum_{i=1}^{i=m} a_{2i}^2 s_i^2}},$$

where the s's are the standard deviations of the ϵ's. The formula (4) for r is well adapted to the discussion of the connection between the value of r and the relationship between x and y. We shall use it first to show that under certain conditions r will not furnish a satisfactory measure of the particular form of relationship in which we are interested.

Consider, for example, the use of correlation in educational investigations. A value for r is computed from the performances of a group of persons in two fields of mental activity, such as two school subjects, and the closeness of relationship between the two fields or subjects is discussed on the basis of this value. It is clear that the value of r is a good measure of the tendency of the members of the group having a given deviation from the mean ability of the whole group in one field, to have an average deviation of corresponding magnitude from the mean ability of the whole group in the other field. It is certainly useful to be able to measure such a tendency, but there is something else which it is more useful from the educational standpoint to be able to measure. Suppose the average ability of the whole group in one field is increased a certain amount by training in that field, and this in turn causes a certain increase in the average ability of the whole group in the other field. The ratio of this latter increase to the former, when each is measured in terms of the standard deviation of the group in the corresponding field, is a very important quantity in educational investigations; it is vital for example in the discussion of such questions as disciplinary values.

We will now proceed to show that under certain conditions this ratio may be much greater than r. Since ability in any complicated field of mental activity like a school subject may be regarded as a function of a great many elementary abilities, the abilities x and y in two subjects may be represented as in equation (2). If we expand about the mean values of the ϵ's at any given time and neglect higher powers than the first,[6] we get equations of the type (3).

Since ability in each of the two subjects will in general depend on certain elementary abilities not involved in the other, we shall consider a case where certain of the a's in the first equation in (3) are zero and certain of the a's in the second equation are zero. Let us suppose then that

$$(5) \qquad \begin{aligned} a_{11} = a_{12} = \cdots = a_{1p} = 0, \\ a_{2,\,m-p+1} = a_{2,\,m-p+2} = \cdots = a_{2m} = 0, \end{aligned}$$

and let us suppose further that

$$(6) \qquad \left\{ \begin{aligned} a_{j,\,p+1} = a_{j,\,p+2} = \cdots = a_{j,\,m-p} = a > 0 \\ (j = 1, 2), \\ a_{1,\,m-p+1} = a_{1,\,m-p+2} = \cdots = a_{1m} = 100a, \\ a_{21} = a_{22} = \cdots = a_{2p} = 100a, \\ s_1 = s_2 = \cdots = s_p = s, \\ m = 902p. \end{aligned} \right.$$

If by training in one subject the average ability of a group of persons in that subject is increased a certain amount, it is reasonable to suppose that this increase has been uniformly distributed in the way of corresponding increases in each of the elementary abilities involved in that subject. Since from (6) the standard deviations of the elementary abilities are all equal in the present case, a uniform distribution of the increase would imply an equal increase in each elementary ability. We will assume then that after training in the subject, the mean value of each ϵ of which x is a function is increased by a quantity δ. Since the η's occurring on the right-hand side of the first equation in (3) are deviations from the original means of the ϵ's, the mean value of each of them will now be δ instead of zero.

[6] In the present instance we neglect higher powers on the assumption that ability in the given subject is approximately a weighted mean of the elementary abilities on which it depends.

Hence, in view of (5) and (6), the mean value of x will be

$$x_0' = x_0 + 1{,}000\ p\ a\ \delta. \tag{7}$$

Similarly the mean value of y after the increase in the average value of the ϵ's involved in x, the ϵ's involved in y but not in x remaining constant, will be

$$y_0' = y_0 + 900\ p\ a\ \delta. \tag{8}$$

Therefore, since the standard deviations of x and y, s_x and s_y, are equal,

$$\frac{y_0' - y_0}{s_y} \Big/ \frac{x_0' - x_0}{s_x} = 0.9. \tag{9}$$

It is apparent from (9) that in this instance a certain increase in the average ability x will be accompanied by an increase almost as great in the average ability y.

If r is to be considered in all cases a reliable measure of the closeness of relationship between two fields of mental activity, it ought to be approximately equal to the ratio in (9). Let us see what its value actually is. Making use of equations (4), (5) and (6), we get

$$r = \frac{900pa^2}{\sqrt{(900pa^2 + 10{,}000pa^2)(10{,}000pa^2 + 900pa^2)}} \tag{10}$$
$$= 0.08 \text{ approximately.}$$

We have dealt here with a special case, but it is easy to see from the above discussion that in many other cases we would have discrepancies of the same sort. Hence it is apparent that it is not safe to assume off-hand that r is always the best measure of the relationship between two fields of mental activity. It may be a very poor measure of the form of relationship in which we are interested.[7]

The question naturally arises, under what conditions will r be a good approximation to the value of the ratio in (9)? It is the purpose of the rest of this paper to obtain certain sufficient conditions that this will be the case. It is very easy to see that if all the a's of equation (3) which are not zero are equal to each other in absolute value, and furthermore if the standard deviations of the ϵ's are all equal to each other, r will be exactly equal to the ratio in (9). This leads one to suspect that if these conditions are fulfilled to a sufficient degree of approximation, r will not differ very much from this ratio.

In discussing the general case there are really two ratios of the type (9) to be considered, according as the training has been in the field corresponding to x or in the field corresponding to y. In the special case discussed above these two ratios were identical, so we only considered one of them. Under the hypotheses we shall make in what follows, the discussion for one ratio is practically the same as the discussion for the other, so here too we shall only consider one of them.

We will investigate first the case where all the a's on the right-hand side of the equations in (3) are positive or zero. It is apparent that there is no loss of generality in supposing that the a's which are zero in the first equation are the a's of the first p terms and the a's which are zero in the second equation are the a's of the last q terms. In particular p, or q, or both of them, might be zero.

Since the standard deviations of the ϵ's involved in x are no longer necessarily equal to each other, a uniform distribution over these ϵ's of an increase in x would result in an increase in each ϵ proportional to its standard deviation. Let us suppose then that after training in the field corresponding to x the mean value of each ϵ_v involved in x has been increased by an amount $s_v\delta$. Representing as before by x_0' the mean value of x after the increase in the ϵ's we have

$$x_0' - x_0 = \sum_{v=p+1}^{v=m} a_{1v}s_v\delta. \tag{11}$$

Similarly, if y_0' represents the mean value of y after the increase in the ϵ's, we have

$$y_0' - y_0 = \sum_{v=p+1}^{v=m-q} a_{2v}s_v\delta. \tag{12}$$

[7] We have restricted ourselves in the foregoing discussion to the case of relationship between different fields of mental activity. The mathematical part of the discussion, however, will undoubtedly have a bearing on many applications of the theory of correlation. If for any two variables x and y, the a's of equation (3) satisfy the conditions of our special case, the ratio of the common factors involved in the variation of x and y to all the factors, will, for each variable, be 0.9. Hence r, which is given by (10), will not be a good measure of the closeness of relationship between the two variable quantities.

Hence we have

$$(13)\qquad R=\frac{y_0'-y_0}{s_y}\Big/\frac{x_0'-x_0}{s_x}=\frac{\sum\limits_{v=p+1}^{v=m-q}a_{2v}s_v}{\sum\limits_{v=p+1}^{v=m}a_{1v}s_v}\cdot\frac{\sqrt{\sum\limits_{v=p+1}^{v=m}a_{1v}^2s_v^2}}{\sqrt{\sum\limits_{v=1}^{v=m-q}a_{2v}^2s_v^2}}.$$

Let us now suppose that two positive quantities a and s, and a positive quantity $\rho<1$, exist, such that

$$(14)\qquad \begin{aligned} &a(1-\rho)\leqq a_{1i}\leqq a(1+\rho)\quad (i=p+1,p+2,\cdots,m),\\ &a(1-\rho)\leqq a_{2i}\leqq a(1+\rho)\quad (i=1,2,\cdots,m-q),\\ &s(1-\rho)\leqq s_i\leqq s(1+\rho)\quad (i=1,2,\cdots,m). \end{aligned}$$

It follows readily from (13) and (14) that

$$(15)\qquad \begin{aligned} \left(\frac{1-\rho}{1+\rho}\right)^4\frac{m-p-q}{\sqrt{(m-p)(m-q)}}&<R\\ &<\left(\frac{1+\rho}{1-\rho}\right)^4\frac{m-p-q}{\sqrt{(m-p)(m-q)}}. \end{aligned}$$

Similarly from (4) and (14) we have

$$(16)\qquad \begin{aligned} \left(\frac{1-\rho}{1+\rho}\right)^4\frac{m-p-q}{\sqrt{(m-p)(m-q)}}&<r\\ &<\left(\frac{1+\rho}{1-\rho}\right)^4\frac{m-p-q}{\sqrt{(m-p)(m-q)}}. \end{aligned}$$

We might obtain still narrower limits for the values of R and r than those given in (15) and (16). It is apparent from the limits obtained, however, that if ρ is sufficiently small, r will furnish a good approximation to the value of R.

We will now consider the case where some of the a's on the right-hand side of the equations in (3) are negative. Let us suppose that the first λ of the $(m-p-q)$ η's that appear in both equations have coefficients of the same sign in the two equations, and that the remainder, μ in number, have coefficients of opposite signs. Obviously, an increase in x that is uniformly distributed with regard to the ϵ's involved in x, will be accompanied by a decrease in those ϵ's for which the corresponding η's have negative coefficients in the first equation in (3); also an increase in an η having a negative coefficient in the second equation will cause a corresponding decrease in the value of y. Hence we have for the ratio in (9)

$$(17)\qquad R=\frac{\dfrac{y_0'-y_0}{s_y}}{\dfrac{x_0'-x_0}{s_x}}=\frac{\sum\limits_{v=p+1}^{v=p+\lambda}|a_{2v}|s_v-\sum\limits_{v=p+\lambda+1}^{v=m-q}|a_{2v}|s_v}{\sum\limits_{v=p+1}^{v=m}|a_{1v}|s_v}\cdot\frac{\sqrt{\sum\limits_{v=p+1}^{v=m}a_{1v}^2s_v^2}}{\sqrt{\sum\limits_{v=1}^{v=m-q}a_{2v}^2s_v^2}}.$$

Let us now suppose that the a's and the s's satisfy equations of the type (14), *i. e.*, equations obtained by replacing the a's in those equations by their absolute values. Then it is easy to see that if $\lambda>\mu$, and ρ is sufficiently small,

$$(18)\qquad \begin{aligned} &\frac{\lambda-\mu}{\sqrt{(m-p)(m-q)}}\cdot\frac{(1+\rho^2)(1-\rho)^2}{(1+\rho)^4}\\ &\quad-\frac{2(\lambda+\mu)}{\sqrt{(m-p)(m-q)}}\cdot\frac{\rho(1-\rho)^2}{(1+\rho)^4}<R\\ &<\frac{\lambda-\mu}{\sqrt{(m-p)(m-q)}}\cdot\frac{(1+\rho^2)(1+\rho)^2}{(1-\rho)^4}\\ &\quad+\frac{2(\lambda+\mu)}{\sqrt{(m-p)(m-q)}}\cdot\frac{\rho(1+\rho^2)}{(1-\rho)^4}. \end{aligned}$$

Furthermore, in view of (4), we have for r

$$(19)\qquad \begin{aligned} &\frac{\lambda-\mu}{\sqrt{(m-p)(m-q)}}\cdot\frac{1+6\rho^2+\rho^4}{(1+\rho)^4}\\ &\quad-\frac{4(\lambda+\mu)}{\sqrt{(m-p)(m-q)}}\cdot\frac{\rho(1+\rho^2)}{(1+\rho)^4}<r\\ &<\frac{\lambda-\mu}{\sqrt{(m-p)(m-q)}}\cdot\frac{1+6\rho^2+\rho^4}{(1-\rho)^4}\\ &\quad+\frac{4(\lambda+\mu)}{\sqrt{(m-p)(m-q)}}\cdot\frac{\rho(1+\rho^2)}{(1-\rho)^4}. \end{aligned}$$

The corresponding inequalities for the cases where $\lambda\leqq\mu$ are easily obtained. It follows from (18) and (19) or the corresponding inequalities, that r will be a good approximation to R if ρ is sufficiently small.

The case where all the a's on the right-hand side of (3) that are not zero, are negative, does not seem to have any great interest in connection with the applications discussed in this paper. In any event the treatment of that case presents no new difficulties, so we shall not consider it here.

This paper makes no pretense of being an exhaustive treatment of the subject under consideration. Its main object has been to point out as briefly as possible the danger of assuming that the coefficient of correlation is necessarily a satisfactory measure of all forms of relationship between two variable quantities, and at the same time to suggest a method of attack for determining in what way a particular relationship depends on the value of this coefficient.

CHARLES N. MOORE
UNIVERSITY OF CINCINNATI

AN ABERRANT ECOLOGICAL FORM OF UNIO COMPLANATUS DILLWYN

THE variety of *Unio complanatus* Dillw. which is here described was found at Songo Pond, about three miles south of Bethel, Me. The specimens from which it is described were collected in August, 1913. The pond is a headwater of the Crooked River, one of the larger tributaries of the Presumpscot. It lies in a glacial scoop in alluvial sand, and is fed by springs mainly. A small brook a mile long enters it also. The country rock is a granitic gneiss of the eastern range of Montalban gneisses, and the intrusive granites scattered here and there are of the same mineralogy. There is no limy rock in any form within many miles, a fact which will account for the peculiar structure of the shell. The specimens were picked up on a very gently sloping beach of round-grained sand, along the western shore of the pond, and in about two feet of water. The pond is about a mile and a quarter long, from north to south, and averages a quarter of a mile in width.

So far as I can determine, the soft parts of the animal are in every way normal for the species. The aberrancy occurs in the valves, and is in structure and in shape.

The largest of my specimens, and the largest I have seen in the course of eight summers' picking, measures two and three quarters by one and a half inches over all. The greatest thickness, from umbo to umbo, is three quarters of an inch. The following features are normal: hinge size and place, umbo size, place and shape, lateral and pseudocardinal teeth size and shape, scars, pallial line, and sculpture. Epidermis is of normal color, but thicker than usual, and overlaps the edge of the hard part of the shell up to 3/32 of an inch, being most extended at the siphonal region and along the anterior part of the ventral edge in many specimens.

The shape of the shell is almost identical with that of *Anodonta marginata* Say, being roughly rhomboidal. It does not resemble the specimens of *Unio complanatus* from other regions in the American Museum at New York, in this respect. From the posterior end of the hinge, the dorsal edge slopes ventrally, straight, at an angle between 35 and 40 degrees from the line of the hinge. This portion of the edge is nearly straight and about as long as the hinge. It rounds off into the small semicircle of the posterior end. In mature specimens there may be a slight flattening of the posterior end at the point where the mantle forms a pair of siphons by its folding and coherence, but this is not constant and I find it only in the largest specimens. The ventral edge is not a uniform curve, but approaches more or less to three straight lines, equal in length, each making an angle of about ten degrees with the line continuing the edge beyond it. The anterior end has the usual graceful elliptical outline, forming a large curve from hinge to ventral edge.

There are no rays visible on any of my specimens.

The most peculiar feature of the shell is the exceedingly small amount of mineral matter in it. When fresh the shells are horny and somewhat flexible, not unlike two layers of parchment pasted together, in texture. Alcoholic material and fresh are alike easily cut with a small shears, and there is no cracking. The thin nacreous layer breaks into small angular chunks, which adhere to the epidermis. I found only the faintest traces of a prismatic layer, in the largest specimens. Smaller ones fail entirely to show it. In my largest specimens there is at the umbo a larger amount of mineral matter, but even here it is hardly more in amount than at the margin in the normal shell of this species. The epidermis seems to me to be nearly twice as thick as in the normal type. In many specimens I found grains of

sand imbedded in the outer part of the epidermis, and apparently thoroughly encased.

This feature is quite obviously the result of the nature of the water in which the shells grew. There is no lime to be had save what little weathers out of the felspar of the country rocks: as these are largely soda felspars, this amount is indeed small.

If this be a variety worthy of a name, I would suggest that it be called *Unio complanatus* var. *mainensis*. It seems to be a form native to the granitic region of New England, and so far as I know is found mainly in western Maine. It is common throughout the ponds and lakes of Oxford county in that state. Since 1909 it has become so plentiful in Songo Pond that one can pick up ten dozen in half a hour, within three hundred feet along the beach. I have been in the habit of gathering it to boil for eating: it is quite palatable if cooked just the right time and with much salt.

My thanks are due to Dr. L. P. Gratacap, of the American Museum of Natural History, for aid in determining the shells, and to Professor F. Loomis, of Amherst College, for suggesting that the variety might be of general interest.

STEPHEN G. RICH

ITHACA, N. Y.

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

A SPECIAL MEETING of the American Phytopathological Society and its Pacific Division, was held at the University of California, from August 3 to 5. Addresses of welcome were delivered by Dr. Herbert J. Webber, director of the Citrus Experiment Station and Dean of the Graduate School of Tropical Agriculture, Riverside, California, and Professor R. E. Smith, president of the Pacific Division of the society.

Dr. Haven Metcalf responded for the society.

The following program was presented:

International Phytopathology: OTTO APPEL, Dahlem, near Berlin, Germany. (Read by Dr. C. L. SHEAR. This will be published in full in *Phytopathology*.)

Pythiacystis Infection of Deciduous Nursery Stock: E. H. SMITH, University of California, Berkeley, Calif.

A dieback of young deciduous trees, which occurred extensively in northern California the past two seasons, has been traced to a species of *Pythiacystis*, morphologically identical with *P. citrophthora*. Most of the root stock is apparently immune, but above the bud the bark is infected in one to several cankers, which often girdle the tree and kill back the whole top. Profuse gumming occurs. The fungus has been isolated from peach, almond, pear and plum, and the disease produced by inoculation in apple, pear, peach, almond, apricot, prune and cherry, all from one-year-old stock. Similar cankers have been produced by inoculation with *P. citrophthora* isolated from lemon fruit. A pythiaceous fungus has been twice isolated from almond cankers and successfully inoculated into almond, which readily develops an oospore stage. This has different characters of growth from the original strain, and a less degree of pathogenicity, but may ultimately be placed in the same species.

Two Eastern Forest Diseases which Threaten the Pacific States: HAVEN METCALF, U. S. D. A., Washington, D. C. (with lantern).

The speaker exhibited lantern slides and specimens of the chestnut-bark disease (*Endothia parasitica*) and the white-pine blister rust (*Cronartium ribicola*). The danger which these diseases present to the cultivated chestnut of the Pacific states and to the native stand of five-leaf pines was indicated. Especially to be considered is the danger to the very valuable species *Pinus lambertiana* and *P. monticola*. The speaker advocated rigid state quarantines against nursery stock of the genus *Castania*, the 5-leaf species of pines, and the genus *Ribes*.

Beet Blight: R. E. SMITH, University of California, Berkeley, Calif.

Specimens of diseased beets were exhibited and the methods being employed in the study of the disease were explained and illustrated. The structure of the diseased beets was dis-

cussed and certain peculiarities were described. Possible connection with certain bacteria was suggested and the nature and difficulties of the problem concerned were discussed. In the discussion which followed the paper Director Ball, of Utah, and a number of others gave their views on certain phases of the problem, especially with regard to the relation of the disease to insects. Mr. August Boncquet, of Spreckels, California, gave support to the suggestion that only insects which have been in contact with diseased beets are capable of transmitting the disease.

Forest Pathology: E. P. Meinecke, U. S. D. A., San Francisco.

A number of forest diseases were exhibited, including interesting and important rusts and mistletoes. Several new hosts were shown in the collection, and important but hitherto not well-known forms were included in the demonstration.

Northwestern Apple Anthracnose: H. S. Jackson, Corvallis, Oregon.

Specimens were shown of the disease in various forms, and the technical phases, particularly culture work and cross inoculations with the different spore forms, were discussed and the economic status of the disease briefly indicated.

The second session was held in the laboratory of plant pathology Thursday morning, August 5, at 9:30.

Apple Mildew: W. S. Ballard, U. S. D. A., Watsonville, Calif.

The nature of this disease was explained briefly, and an account of the history of the efforts which have been made to discover effective control measures was given. Use of colloidal sulphur, prepared by dissolving sulphur in melted resin, grinding and putting into ammonia water, was described. The difficulties involved in the use of sulphur in the California coast districts on account of the danger of injury to the trees were discussed and the reasons for the use of unusually dilute spray formulas were mentioned.

Mottled Leaf of Citrus Species: J. T. Barrett, Riverside, Calif.

Professor Barrett reviewed the main features of this disease and showed typical specimens. No specific cause has been discovered and the disease is still classed as a non-parasitic disease. The diseased leaves contain more starch than normally on account of defective translocation, and apparently also an excess of nitrogen. Some relation appears to have been discovered between fertilization with nitrate of soda without the addition of vegetable material and mottled leaf, but it was pointed out that this is probably not a direct effect of the materials used, but of the soil condition produced, since in plots in which liberal use had been made of the vegetable material the disease has not appeared. The disease is being studied at Riverside from all possible points of view and is being treated as a station problem and not exclusively by any one department. The possibility of an infectious chlorosis is also being investigated. In the discussion Professor F. S. Earle pointed out that there are probably two distinct types of mottled leaf in Cuba and the Isle of Pines, arising from what is probably a specific disease of the small roots and from general unfavorable soil conditions.

Bacterial Canker of Cherry and Filbert Disease: H. P. Barss, Corvallis, Oregon.

Griffin showed the bacterial origin of the bud blight in cherries. The identity of cause for bud blight and body canker was shown by the speaker by means of inoculations made in the fall. Inoculations at other seasons were not successful. The disease is most destructive during the first seven or eight years of the life of the tree. It is now largely controlled by planting Mazard apricot, prune and Simone plum.

The filbert disease is also caused by bacteria, being in this case a yellow organism similar to the walnut blight bacterium. A leaf spotting and killing of twigs are produced and cankers are formed, succulent tissue being susceptible.

Crown Rot of Fruit Trees: Histological Studies: J. G. Grossenbacher, U. S. D. A., Washington, D. C. (Read by title.)

Some New and Old Methods in Plant Pathology: J. Franklin Collins, U. S. D. A., Washington, D. C. (Read by title.)

Citrus Gummosis and Melaxuma: H. S. Fawcett, Whittier, Cal.

These diseases were illustrated by means of lantern slides and brief explanations, together with a set of specimens and photographic enlargements in the laboratory. The former is caused by the fungus *Pythiacystis citrophthora* S. and S., and the latter by a fungus which is probably a *Dothiorella.*

Fruit Stain and Wither Tip of Citrus: J. T. Barrett, Riverside, Cal.

Effects of the fungus *Colletotrichum gloeosporioides* were illustrated on twigs and fruit. Dr. Barrett stated that he did not yet have evidence that the fungus is capable of infecting thoroughly sound and healthy tissue of leaves and twigs, but infection of the fruit through germination from appressoria, killing small areas of rind, and later development of the fungus cause serious fruit rotting in addition to the tear-stain marks upon the surface.

Observations on Prune Rust (Puccinia Pruni-spinosæ Pers.) in Southern California: J. T. Barrett, Riverside, Cal.

This fungus has become serious at times in southern California on apricots and peaches. The characteristic spots and injury to the orchard by defoliation were shown by lantern slides. In some cases early fall pruning has stimulated fall growth in which foliage remains alive through the winter and rust developed in this has caused early spring infection with very detrimental effects to the orchards.

Coryneum Fruit Spot of Apricots: J. T. Barrett, Riverside, Cal.

Characteristic spotting was illustrated by lantern slides. This disease is not of so wide distribution in apricots as has been supposed. Accordingly, spraying operations carried out for this trouble have not given satisfaction in all cases.

Walnut Blight and Crown Gall: C. O. Smith, Whittier, Cal.

The symptoms of this disease were illustrated by means of lantern slides and specimens were shown in the laboratory.

August 5, 2 P.M. The program was continued in the laboratory of plant pathology.

Peridermium Harknessii Moore, and Cronartium Quercuum (Berk.): E. P. Meinecke, U. S. D. A., San Francisco, Cal.

The results of extensive observations on these rusts and inoculation experiments with the different spore forms were given.

An Established Asiatic Gymnosporangium in Oregon: H. S. Jackson, Corvallis, Oregon.

Results of careful studies and cross inoculations with a newly imported *Gymnosporangium* discovered on Oriental pears in Oregon were given.

The Need of a Pure Culture Supply Laboratory for Plant Pathology in America: C. L. Shear, U. S. D. A., Washington, D. C. (To be published in full in the October number of *Phytopathology.*)

Studies of the Rhizoctonia Disease of Potatoes: J. H. Corsaut, Corvallis, Oregon.

On account of the seriousness of potato troubles due to *Rhizoctonia* in the state of Oregon, studies on this disease were undertaken. Affected plants and tubers were secured from different localities and a large number of different strains of the causal organism were isolated from sclerotia on the tubers, from sterile mycelium on the underground parts of the plant, from basidium-bearing mycelium, and from individual basidiospores. The cultural characters of these strains were similar, but showed some variation. A splendid development of the typical *Corticium* (*Hypochnus*) stage appeared on the stems of young plants grown in sterilized soils from sterilized seed pieces which had been inoculated with pure culture of the organisms isolated from sclerotia, sterile mycelium, and single basidiospores. A number of different varieties of potatoes were inoculated with *Rhizoctonia* grown under similar conditions and the effects noted. Some varieties proved extremely susceptible, while others were rather strongly resistant. It was also found that when grown on sterile raw plugs cut from different varieties of potatoes the fungus developed rapidly on certain varieties and but slowly on others. By artificial

means healthy *Rhizoctonia*-free potato plants were made to reproduce both the "aerial potato" condition and the "little potato" condition, which are frequent consequences of natural attacks of *Rhizoctonia*. These experiments indicate that the abnormal effects referred to are purely secondary results of the *Rhizoctonia* attack caused by interference with the normal process of food storage in the plant.

Studies of Monilia Blight of Fruit Trees: G. B. Posey, Corvallis, Oregon.

From blighted twigs of apricot, prune and pear there was isolated by different members of the staff of the department of botany and plant pathology of the Oregon Agricultural College during the season of 1913 a species of *Monilia*, apparently unlike, in cultural characters, the common "brown rot" fungus of the stone fruits (*Sclerotinia cinerea* Bon.), which is abundant in Oregon. An investigation of this blight-producing *Monilia* was undertaken. Over fifty strains were isolated and a comparison made with over fifty strains of *Sclerotinia cinerea* from Oregon and other parts of this country and with four strains of *Sclerotinia fructigena* secured from England. Culture studies on a great variety of artificial media, inoculations into various kinds of fruits, and inoculations upon the twigs of various kinds of fruit trees proved that this apparently unrecognized species of *Monilia* is entirely distinct from the strains of *S. cinerea* and *S. fructigena* used for comparison.

The investigation thus far has shown that this *Monilia* is apparently common in the Pacific Northwest. It has been found on blighted blossoms, spurs and twigs, and sometimes on mummied fruits of pear, quince, apricot, peach, prune, plum and cherry. It usually starts in the spring as a blossom blight and works back into the spurs and branches, where the progress of the fungus is checked as the season advances. Tender shoots are sometimes attacked. Sporodochia are formed on the affected parts during the same season and spores are produced until late in the following spring. No ascosporic stage of the *Monilia* under discussion has as yet been found, although apothecia of the common *S. cinerea* were collected abundantly on mummied fruits of apple, pear, prune, plum, peach, apricot and cherry. The investigation will be continued.

A Podosporiella Disease of Germinating Wheat: P. J. O'Gara, Salt Lake City, Utah.

On examining a weak strain of wheat in Salt Lake Valley the trouble was traced back to the seed, the content of the kernels of which were found to have been largely consumed by a dark brown, septate mycelium, which did not appear on the surface. The seed coat was penetrated later by the fruiting stalks of the fungus, which was found to be a new species of *Podosporiella*. The fungus is not considered to be a true parasite, since it does not attack the kernel till about the time of germination, and has never been found in the growing portions of the plant. The disease is found to be most prevalent in volunteer wheat, and where several crops had been grown with only surface cultivation.

The Utilization of Certain Pentoses and Compounds of Pentoses by Glomerella cingulata (Stonem.) S. and v. S.: L. A. Hawkins, U. S. D. A., Washington, D. C.

In the experiments an attempt was made to determine the effect of the apple bitter-rot fungus upon the pentose-containing compounds of the apple fruit, the relative value of certain pentoses and compounds of pentoses as sources of carbon for this fungus, and the effect of an aqueous extract of the fungus mycelium upon xylan. It was found that the fungus increased the alcohol-soluble pentosan content of the apple fruit, but decreased the total pentosan content. The fungus readily utilized either xylose, arabinose xylan or arabin as sources of carbon. The two pentoses were more favorable sources of carbon than glucose. Aqueous extracts of the fungus mycelium when allowed to act on xylan produced xylose. It is evident that the fungus secretes an enzyme, which hydrolyzes xylan to xylose.

Armillaria or Oak Fungus Disease in California: W. T. Horne, University of California, Berkeley, Cal.

Cultures and specimens were exhibited and the action of the fungus briefly described.

There was considerable discussion of this important disease by a number of those present.

The sessions were presided over by Dr. Haven Metcalf in the absence of the president and vice-president of the American Phytopathological Society, and Professor R. E. Smith, president of the Pacific Division, and Professor H. S. Jackson, newly elected president of the Pacific Division, respectively. The attendance at these sessions varied from forty to fifty.

Wednesday, August 4, was spent with the botanists at Stanford University, and the plant pathologists joined the biologists in a dinner in San Francisco in the evening.

Following the reading of Dr. Shear's paper a motion was adopted directing the chairman to appoint a committee for the purpose of considering the question of the establishment of a culture supply laboratory. C. L. Shear, chairman, and L. R. Jones were appointed, with power to select a third member.

In the intermission between the second and third sessions, a business meeting of the Pacific Division was held, in which a report was made by the secretary-treasurer as to the activities of the society and its financial condition. Officers for the ensuing year were elected as follows: H. S. Jackson, president; J. T. Barrett, vice-president; W. T. Horne, secretary-treasurer. The question of affiliation with the Pacific Division of the American Association for the Advancement of Science was reported on and the matter of the next meeting was left until the next meeting of that society should be decided. The matter of relation to the parent society was then taken up and the report of the joint committee was adopted. The adoption of this report changes the name of the local society to the American Phytopathological Society, Pacific Division, and also reestablishes the distinction originally made between associate and active members, active members being those who are also members of the parent society.

C. L. Shear,
Secretary-Treasurer,
W. T. Horne,
Secretary-Treasurer,
Pacific Division.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, SECTION B, PHYSICS

The recent, August 2–7, California meetings of Section B of the American Association for the Advancement of Science were pleasant and profitable in every particular. The programs for three days, Tuesday, Wednesday and Thursday, had been amply provided for by a special committee of the Pacific Coast Division, of which Professor Fernando Sanford was chairman. These sessions, presided over by Vice-president Lewis were devoted to the presentation of rather full, invited papers and demonstrations on spectroscopy, high tension electric currents, and physics of the atmosphere. Friday's meetings, at which many brief papers were presented, were in charge of the American Physical Society, with President Merritt presiding.

All these meetings, however, were regarded as joint meetings between Section B and the Physical Society. Abstracts of the papers presented therefore will appear in the *Physical Review.*

Wednesday's meetings were held at the Stanford University, and given over entirely to a "Discussion and Demonstrations of High Potential Electric Currents" by Professor Harris J. Ryan. To say that these demonstrations, made in a building constructed especially for this purpose, were remarkable, is but to echo the statement of every one fortunate enough to see them.

But not all the meetings were for the presentation of scientific papers. Tuesday's luncheon given by Professors Lewis, Haskell and Leuschner at the Faculty Club, University of California, Wednesday's dinner at the Jules Café, San Francisco, and Saturday's excursion to the Lick Observatory were some of the most important meetings of the entire week, important because they contributed, as scarcely anything else could have contributed, to the perpetuation of old friendships and the beginning of new ones.

The vote of thanks, therefore, extended at the last session to the Pacific Coast Committee, to the University of California, to the Stanford University and especially to the physicists of the two institutions for making these meetings of Section B and the Physical Society so thoroughly successful was amply deserved and most heartily given.

W. J. Humphreys,
Secretary, Section B

SCIENCE

FRIDAY, OCTOBER 29, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE IMPORTANCE OF GEOGRAPHICAL RESEARCH[1]

THIS year, when the British Association is holding its meeting in times of the utmost gravity, the changed conditions which have been brought about by this war must occupy the attention of all the sections to a greater or less extent, and our attention is being called to many fields in which our activities have been less marked or more restricted than they might have been, and where more serious study is to be desired. The same introspection may be usefully exercised in geography, for although that branch of knowledge has undoubtedly advanced in a remarkable degree during the last few decades, we have certainly allowed some parts of the subject to receive inadequate attention as compared with others, and the necessity for more serious study of many of its problems is abundantly evident.

Nor is the present occasion ill adapted to such an examination of our position, for when the British Association last met in this city, now twenty-eight years ago, the president of this section, General Sir Charles Warren, urged in his address the importance of a full recognition of geography in education on the grounds that a thorough knowledge of it is required in every branch of life, and is nowhere more important than in diplomacy, politics and administration.

Matters have certainly advanced greatly since that time, and a much fuller appreci-

[1] Presidential address to the Geographical Section of the British Association, Manchester, September, 1915.

ation of geography now exists than that which formerly prevailed. At the time of the address to which I have referred the serious study of geography in this country was on the eve of important developments. The Council of the Royal Geographical Society had for some time been urging the importance of geography being studied at the universities so that there should be an opportunity for advanced students to qualify themselves as scientific geographers by study and original research in the subject. The time had arrived for this ideal to become an accomplished fact, and in the following year, 1888, a reader in geography was appointed at Oxford University, and a lectureship in the same subject was established at Cambridge. Since then the advance has been steady and continuous not only in the increased attention given to the subject, but also in the way in which it is treated. The earlier bald and unattractive statistical presentation of the subject has now been almost everywhere replaced by a more intelligent treatment of it, in which the influences of the various environments upon the life which inhabits a region are appreciated, and the responses to such influences are followed up. Instruction in the subject is given by those who have seriously studied it, who realize its importance, and who are in a position to train up new scientific workers in the field of geography. Though much remains to be done, there should be now a steady output of geographical investigators capable of providing an ever-increasing supply of carefully observed data, which they will have classified methodically and discussed critically, in order that these may be utilized to form sound generalizations as to their relationships and sequence in accordance with the method which is employed in all scientific work.

In order that we may see what advance has been made in the scientific study of geography in this country during the last quarter of a century, we must turn to the results that have been attained by the activity of geographical investigators who have devoted themselves to the serious study of various phenomena, and the detailed investigation of particular regions. If we do so I think that we must admit that the number of original investigators in scientific geography who are extending its scope in this way is not so large as it might be, nor are we yet utilizing sufficiently all the material which is available to us. Any one who will examine the geographical material which has been published in any period which he may select for review will find that purely descriptive treatment still far outweighs the analytical treatment which alone can lead to definite advances in scientific geography. If pleasing descriptions of this or that locality are sought for, they are for the most part to be found readily in the very large amount of such material that has been and is being published each year by residents, travelers and explorers; but if information is desired in the prosecution of a piece of geographical research, we are checked by the lack of precise details. Few of this class of descriptions are sufficiently definite to enable the necessary comparisons to be made between one locality and others which are similarly situated; thoroughly quantitative treatment is for the most part lacking, and while a pleasing picture is drawn which is probably true in character, it is usually inadequately furnished with those definite facts which the geographer requires.

I propose, therefore, to examine a little more closely the question of geographical investigation and research in order to see where we stand and in what direction it behooves us to put forth our energies to the end that a branch of knowledge which is of

such importance shall rest upon that basis of detailed study and investigation which alone can supply the starting-point for further advance. The intricate and complicated character of the subject, the extent of its purview, the numerous points at which it touches and imperceptibly passes into other well-defined branches of knowledge, render the study of geography very liable to degenerate into a purely descriptive treatment of the earth's surface and all that is to be found thereon, rather than to follow the narrow path of scientific progress in which the careful collection of data furnishes the material for systematic discussion and study in order that trustworthy generalizations may be reached.

The opportunity to undertake long journeys through distant lands comes to a few of us, but this is not the only direction in which research can be profitably undertaken, for there is no part of these islands where a geographer can not find within his reach some geographical problem which is well worth working out, and which, if well and thoroughly done, will be a valuable contribution to his science. Even for such as can not undertake such field work the library will provide a host of subjects which have not received nearly the amount of attention and of careful study that they deserve. The one thing essential is that the study should be as thorough as possible, so that all the contributory lines of evidence shall be brought together and compared, and so that the result may prove to be a real addition to geographical science on which other workers may in their turn build.

For those who desire to undertake such investigations there is at any rate no lack of geographical material, for travelers, explorers, and others engaged in various occupations in every part of the world are continually recording their experiences and describing their surroundings in books and pamphlets; they recount their experiences to the Geographical Societies, who apparently have no difficulty in obtaining communications of wide interest for their meetings. Most portions of the British Empire as well as regions belonging to other nations are in these days more or less fully examined, surveyed and investigated with a view to their development, and those who undertake such work have ample opportunities for the most part for preparing descriptions of the lands in which they have sojourned and with which they are well acquainted. But although the material is so ample the quality of it is not generally such as makes it suitable for an adequate study of the phenomena or the region to which it relates. The ease with which a tract of country or a route can be described by the traveler, and the attractiveness of such a description of a little-known region, results in the provision of a vast quantity of geographical information, the greater part of which has probably been collected by those who have no adequate training in the subject. In such cases it is not uncommon for the writer to disclaim any geological or botanical knowledge, for instance, but the great majority of those to whom the opportunity is given to travel and see new lands and peoples are fully convinced of their competence to describe accurately and sufficiently the geography of the regions which they traverse. But any one who has had occasion to make use of such material in a serious investigation is only too well aware how little precise and definite information he will be able to extract from the greater part of this wealth of material, and in most cases this is due to the traveler's lack of geographical knowledge. He probably does not know the phenomena which should be observed in the type of region which he is

traversing, nor can he read the geographical evidence which lies patent to a trained observer at every point of the journey; much, therefore, of what he records may be of interest, but probably lacks data which are essential to the geographer if he is to understand the geographical character of the region and utilize it properly.

Thus it happens that although the amount of geographical material which is being garnered may be large, the proportion of it which is available for use in a scientific investigation of an area is smaller than is probably realized by those who have not made the experiment. And yet it is only by this scientific investigation of selected localities or of a single phenomenon and by working them out as thoroughly as possible that any real advance in geographical science can be made. The accounts of such pieces of work will not appeal to those who desire picturesque descriptions of little-known lands, but they will be welcomed by geographers who can appreciate the value of such studies. There should now be an ever-increasing number of such geographers, trained to proceed in their investigations by the true scientific method, and there should be a very considerable amount of sound work in various branches of the subject which aims at thoroughly investigating some phenomenon, or group of phenomena, so as to present a grouping of data, carefully verified and critically discussed, in order to arrive at conclusions which may form a useful addition, however small, to the sum of our geographical knowledge.

So far as I am able to judge, the output of serious work of this character is not nearly as large as it should be, and I would indicate some fields in which there is a lack of individual work of this character. Until more of it is undertaken we shall lack in this country the material from which the foundation of scientific geography can be built up, and while our own islands and the various parts of the British Empire furnish unrivalled opportunities for such work, there are still far too many subjects where the most thorough investigations have been made in other countries.

Mathematical geography presents a field for research which had comparatively little attention paid to it in this country. In many respects this part of the subject is peculiarly suitable for such treatment, since it admits of the employment of precise methods to an extent which is not always practicable in cases where so many of the factors can only be approximately defined. The determination of positions on the earth's surface is carried to great refinement in the national surveys of most civilized countries in order to furnish the necessary controls for the preparation of large-scale maps, but when we pass to the location of travellers' routes, where considerable allowance has to be made for the conditions under which the observations have to be taken, we find that very inadequate attention is usually paid to the discussion of the results. Usually a mean value for each latitude, longitude or azimuth is obtained by the computer, and he remains satisfied with this, so that when the route of another traveller follows the same line or crosses it at one or more points, it is almost impossible for the cartographer to say which of the two determinations of any position is entitled to the greater confidence. In this class of work, whether the results are obtained from absolute observations at certain points or from the direction of march, and the distance traversed, it is quite practicable to determine the range of uncertainty within which the positions of different points are laid down, and it is eminently desirable that this should always be done in order that the adjustment of various routes which may intersect in partially-known

regions may be adjusted in accordance with definite mathematical processes. Some important expeditions on which infinite labor and considerable sums have been expended have presented their results, in so far as they relate to the routes which have been followed and the position of points which have been determined, in such a way that it is impossible to say within what precision such positions have been determined, and consequently any combination of these results with those of later expeditions has to be carried out empirically, since adequate data are no longer available for the employment of better and more scientific methods.

This crude and unsatisfactory way of treating observations, which in many cases have been obtained under conditions of the greatest difficulty and even hardship, is largely due to the lack of interest which geographers have shown in this part of their subject. Methods of observation and methods of computation are rarely discussed before any of our geographical societies or in any of our publications, and it is only by such discussions that the importance of properly working out the available material at a time when the observer can be consulted on points which are doubtful, or where further explanation is desirable, becomes generally appreciated.

No set of physical or astronomical observations is ever discussed or even presented without the degree of precision or reliability being definitely stated; yet in geography this sound rule is too often neglected.

There are several regions where travellers' routes intersect which should provide ample material for the careful reduction and adjustment of the results. I fear, however, that there would be great difficulty in obtaining the original observations which are indispensable in such an investigation, and in the interest of research it is highly desirable that the original documents of all work of importance should be preserved and the place where they may be consulted recorded in the published account.

There is room in the geographical investigation of sea and land, even within the limits of the British Empire, for the employment of methods of observation and computation of the highest precision as well as of the simpler and more approximate kinds, but every one who presents the results of his work should deem it his first duty to state explicitly the methods which he employed, and the accuracy to which he attained, in such a form that all who make use of them can judge for themselves of the degree of their reliability.

In such work, while the instruments used are of great importance, too often the briefest description, such as "a 4-inch theodolite," is deemed sufficient. If the observer wishes his work to be treated seriously as a definite contribution to science we require to know more than this, and a clear account of the essentials of the instrument, a statement of its errors, and of the methods of observation adopted are the least that will suffice. The account of any expedition should treat so fully of the instruments, observations and computations utilized to determine the positions of places visited that any one can re-examine the evidence and form his opinion on the value of the results obtained. A mere tabular statement of accepted values, which frequently is all that is provided, is of small value from a scientific point of view. Probably one reason for this state of things is that too little attention is being paid by geographers to their instruments. Theodolites, levels, compasses, clinometers, tacheometers, plane-tables, pantographs, coordinatographs, planimeters, and the many other instruments which are used by the surveyor, the cartographer, the computer, have in no case

arrived at a final state of perfection, but it is seldom that we find a critical description of an instrument in our journals. Descriptions there are from time to time, but these are for the most part weak and insufficient. Not only is a technical description required, which treats fully of both the optical and mechanical details, but we need an extended series of observations with the instrument which have been made under the ordinary conditions of practical work, and these must be mathematically analyzed, and the degree of the reliability of the results clearly demonstrated. The description should be equally thorough and complete, including scale drawings showing the construction of the instrument as well as photographs of it. Nothing less than this is of any use to the scientific cartographer.

While I am on the subject of instruments I would draw attention to the importance of the whole history of the development of surveying instruments. In the latter part of the eighteenth century Great Britain provided the best class of surveying instruments to all countries of Europe, at a time when high-class geodetic work was being commenced in several countries; and about this time von Reichenbach spent a part of his time in this country working in the workshops of Dollond and learning this particular class of work. Upon his return to Bavaria he set up at Munich that establishment which soon provided instruments of the highest class for many of the cadastral surveys which were being undertaken in Central Europe. At Munich there is now a fine typical collection of such instruments, but in this country the early advances of British instrument-makers of surveying instruments are far from being adequately represented in our National Museum in a manner commensurate with their importance. The keen and enlightened zeal of geographers who are interested in this branch of the subject would doubtless quickly bring to light much still remaining that is of great interest, but which is yet unrecognized, while a closer attention to instrumental equipment would lead to improvements and advances in the types that are now employed. There is no modern work in this country on the development of such instruments, and references to their history are conspicuously rare in our journals, so that there is here an opportunity for those whose duties prevent them from undertaking travel or exploration of a more ambitious kind. In the same way, those whose opportunities of field work are few can find a promising field of study in the early methods and practise of surveying which have been discussed by many authors from classical times onwards, and for which a considerable amount of material exists.

In geodesy and surveying of high precision there is ample scope for all who are attracted by the mathematical aspect of the subject; the critical discussion of the instruments and methods employed and results obtained, both in this country and in other lands, provides opportunity for much work of real value, while its bearing upon geology, seismology, etc., has not yet been adequately treated here. The detailed history of this part of our subject is to be found in papers which have been published in the technical and scientific journals of other countries for the most part; here too little attention has been given to the subject, in spite of the large amount of geodetic work which has been executed in the British Empire, and which remains to be done in our colonies and over-seas dominions.

The final expression of the surveyor's detailed measurements is found in the map, and the adequate representation of any land surface on a map-sheet is both a science and an art. Here we require addi-

tional work on all sides, for there is hardly any branch of geography which offers so remunerative a field for activity as cartography. We need the cooperation of trained geographers to study requirements, and to make acquaintance with the limits of technical methods of reproduction, so that they may be in a position to deal with many questions which arise in the preparation of a map regarding the most suitable mode of presentation of data, a matter which is purely geographical, but which at the present time is too often left to the skilled draughtsman. Neither the compilation nor the reduction of maps are merely mechanical processes. The first requires great skill and care as well as technical knowledge and a sound method of treatment if the various pieces of work, which are brought together to make up the map of any considerable area, are to be utilized according to their true worth. This demands a competent knowledge of the work which has been previously done on the region, a first-hand acquaintance with the data collected by the earlier workers, and the critical examination of them in order that due weight may be given to the better material in the final result. This is not a task to be handed over to the draughtsman, who will mechanically incorporate the material as though it were all of equal accuracy, or will adjust discrepancies arbitrarily and not on any definite plan. Such preliminary preparation of cartographical material is a scientific operation which should be carried out by scientific methods and should be completed before the work reaches the draughtsman, who will then have but to introduce detail into a network of controls which has been prepared for him and of which the accuracy at all points has been definitely ascertained. Similarly in the second case the elimination of detail which must of necessity be omitted is an operation needing the greatest skill, a full understanding of the material available, and an adequate appreciation of the result which is being aimed at, such as is only to be found in a competent geographer who has made himself intimately acquainted with all the material which is available and has his critical faculty fully developed.

The use of maps has steadily increased of recent years, but we should look forward to an even more widely extended use of them in the future; and this will be greatly facilitated if there are geographers who have made themselves masters of the technique of map reproduction and, as scientific geographers, are prepared to select such data as are needed for any particular class of map on a well-considered method, and not by the haphazard procedure to which the want of a scientific study of cartographic methods must inevitably lead. The paucity of papers dealing with practical cartography and the compilation of maps is clear proof that this branch of the subject awaits far more serious attention than it now receives.

All these problems are well within the reach of the geographer to whom the opportunity of travel in other regions does not come, and in them he will find ready to his hand a field of research which is well worth working and which will amply repay any labor that is spent upon it. The same precise methods of investigation which are employed in the discussion of observations should be applied to all cartographic material in order to ascertain the exact standard of its reliability, in which is included not only the correctness of distance and direction, but also the accuracy of the information which has been incorporated in it; and these may be brought to bear also on those early maps of which so many are preserved in our libraries in this country. In this field of study several investigators

have already achieved results of great interest and value, but I think that they will be ready to admit that there is here a wide and profitable field of activity for many more workers who will study closely these early maps and, not being contented with verbal descriptions, will use quantitative methods wherever these are possible.

In the study of map projections some activity has been visible in recent years, and we may hope that those who have worked in this branch of the subject will see that British geography is provided with a comprehensive manual of this subject which will be worthy of the vast importance of cartography to the Empire. The selection of suitable projections is receiving much more attention than was formerly accorded to it, but the number of communications on this subject which reach geographical journals are few and far between. The subject is not one which can appeal strongly to the amateur geographer, but its importance renders it imperative that the scientific geographer who realizes its intimate bearing upon all his work should so arrange that the matter does not fall into the background on this account.

A closer relation and a more active cooperation between those who are prepared to work seriously at cartography and its various problems may reasonably be expected to raise the standard of that class of map which is used to illustrate books of travel, or works descriptive of a region. At the present time the inadequate character of many of the maps and plans which are reproduced in such publications shows clearly that the public demand for maps which have been compiled with a view to illustrating the volume in question is still very ineffective.

The whole subject of cartography, with its component parts of map projection, compilation, reproduction, cartometry and the history of its development, is so important, not only to the individual geographer but also to the advancement of scientific geography, that we should aim at fostering it and encouraging the study of it in every way, and it will be the zeal of individuals rather than the benevolent aid of institutions which will achieve this.

But it may be suggested that the lack of activity in mathematical geography is due to the somewhat specialized nature of the subject, and to the fact that the number of those who have received an adequate mathematical training and are prepared to devote themselves to geography is few. When we turn to physical geography in its treatment of the land we do find a field which has been more actively worked, for this is just the one to which the traveller's and explorer's observations should contribute most largely, and where therefore their material should be utilized with the best results. Even here there is room for much more work of the detailed and critical type, which is not merely general and descriptive, but starts from the careful collection of data, proceeds to the critical discussion of them, and continues by a comparison of the results with those obtained in similar observations in other regions.

To take a single branch of physical geography, the study of rivers, the amount of accurate material which has been adequately discussed is small. In our own country the rainfall of various river basins is well known through the efforts of a meteorological association, but the proportion of it which is removed by evaporation, and of that which passes into the soil, has only been very partially studied. Passing to the run-off, which is more easy to determine satisfactorily, the carefully measured discharges of streams and rivers are not nearly so numerous as they should be if the hydrography of the rivers is to

be adequately discussed; for although the more important rivers have been gauged by the authorities responsible for them in many cases, the results have usually been filed, and the information which has been published is usually a final value but without either the original data from which it has been deduced, or a full account given of the methods of measurement which have been employed. For the requirements of the authority concerned such a record is no doubt adequate, but the geographer requires the more detailed information if he is to coordinate satisfactorily the volume discharged with local rainfall, with changes in the rates of erosion or deposition, and the many other phenomena which make up the life-history of a river. Here too it is usually only the main stream which has been investigated; the tributaries still await a similar and even fuller study. A valuable contribution to work of this kind exists in the hydrographical study of the Medway and of the Exe which has been undertaken by a committee of the Royal Geographical Society during recent years, and this may serve as a guide to other workers; but, however welcome such a piece of work may be, I should much prefer to see the hydrography of a tributary of a river system worked out by a geographer as a piece of individual work, just as the geology or the botany or the zoology of a single restricted area is investigated by those whose interests are centered in these subjects.

In the same way we still know too little of the amounts of the dissolved and suspended matter which is carried down by our streams at various seasons of the year and in the different parts of their course. This class of investigation does not need very elaborate equipment, and may provide the opportunity for much useful study, which may be extended as information is increasingly acquired. In this way when numerous individual workers have studied the conditions prevailing in their own areas, and traced them through their seasonal and yearly variations, we shall possess a mass of valuable data with which we may undertake a revision of the results which have been arrived at in past years by various workers from such data as were then at their disposal.

In this one branch of the subject there is ample scope for workers of all interests in the measurement of discharges, in the determination of level, and of the movement of flood waves, in determining the amount of matter transported both in suspension and in solution, in tracing out the changes of the river channel, in following out the variation of the water-table which feeds the stream, in ascertaining the loss of water by seepage in various parts of its course, and generally in studying the hundred other phenomena which are well worth investigating, and which give ample scope for workers of all kinds and of all opportunities. There is work not only in the field, but also in the laboratory and in the library which needs doing, for the full account of even a single stream can only be prepared when data of all classes have been collected and discussed.

On the Scottish lakes much valuable scientific work has been done, and also on some of the English lakes, so that excellent examples of how such work should be done are available as a guide to any one who will devote his spare time for a year or two in making a thorough acquaintance with the characteristics and phenomena of any lake to which he has access.

Coast-lines provide another class of geographical control which repays detailed study, and presents numberless opportunities for systematic investigation and material for many profitable studies in geog-

raphy. The shores of these islands include almost every variety of type, and furnish exceptional opportunities for research of a profitable character, especially as lying on the border-line between the domain of the oceanographer on the one hand and the physiographer on the other. The precise methods of representation which are possible on the land have to give way to a more generalized treatment over the sea, and the shore line is liable to be handed over to the latter sphere, so that there is much interesting and useful work open to any one who will make an accurate and detailed study of a selected piece of coastline, coordinating it with the phenomena of the land and sea, respectively.

The teaching of Professor Davis in pressing for the employment of systematic methods in describing the landscapes with which the geographer has to deal has brought about a more rational treatment, in which due recognition is given to the structure of the area, and the processes which have moulded it, so that land forms are now for the most part described more or less adequately in terms which are familiar to all geographers and which convey definite associated ideas, in the light of which the particular description is adequately appreciated. It has been urged by some that such technical terms are unnecessary and serve to render the writings in which they occur intelligible only to the few; that any one should be able to express his meaning in words and sentences which will convey his meaning to all. There is no great difficulty in doing this, but in such descriptions to convey all that a technically worded account can give to those who understand its terms would be long and involved on account of the numerous related facts which would be included. It is consequently essential in all accurate work that certain terms should have very definite and restricted meanings, and such technical terms, when suitably chosen, are not only convenient in that they avoid circumlocution, but when used in the accepted sense at once suggest to the mind a whole series of related and dependent conditions which are always associated with it.

The compilation of a glossary of geographical terms has been in progress in this country for many years without having reached finality, and much of the difficulty which has been experienced is doubtless due to the fact that so many words have not been consistently used with a well-defined meaning. Such looseness of expression is more liable to occur in the case of foreign words which have been imported in the first case by writers who are not scientifically trained, and therefore do not use them in connection with a specified set of conditions. This, however, is unimportant if only scientific geographers, when they accept a term as a desirable addition to the geographical vocabulary, will associate it definitely with such conditions and use it consistently in that connection. As an instance I may quote the word "sadd," which etymologically means to block, or stop. This term was naturally and reasonably used to indicate masses of uprooted marsh vegetation which had been carried along by the current and, if checked at a sharp bend or a narrow point of the stream, blocked the channel. So long as it is used in this restricted sense it is a useful term to describe a phenomenon which occurs under certain definite conditions and which leads to equally well-defined geographical results. This use of it is associated with a meandering river-channel in an alluvial flood plain, where shallow lagoons occur, in which such marsh vegetation grows luxuriantly; when this vegetation is uprooted by storms and car-

ried by the rising water into the main stream it provides the drift material which makes up the block or "sadd."

But this term has been extended immoderately to mean the region in which these physical conditions occur, or the type of vegetation which grows under these conditions, and even the type of country where such conditions prevail. One writer has even used the word in describing the fossil vegetation of a character such as is associated with marsh lands.

The crystallization of such geographical terms into true technical terms is an important step in the futherance of scientific geography, but it must be done by the geographers themselves, and no means of doing this is more fruitful than the work of original research and investigation in definite areas or on specific problems.

It would take too long to discuss each branch of physical geography and indicate the opportunities for individual effort, but what has been said of one may be said of all the others. Not only in all parts of the Empire, but in these islands also there is ample opportunity for the detailed geographical study of single localities or individual phenomena, just as much as in geology, in botany, or in zoology; and it is these separate pieces of work which, when thoroughly carried out and critically discussed, provide the material on which wider generalizations or larger investigations can be based. Herein lies, therefore, the importance of the prosecution of them by as many workers as possible, and the value of communicating the results to others for criticism and for comparison with the results which they have obtained; for such work, if it can not be made accessible to other workers in the same and related fields, loses a large proportion of its value.

If we now consider some of the problems of human geography we shall find the need for such systematic study to be even greater; for the variable factors involved are more numerous than in physical geography, and many of them are difficult to reduce to precise statement; the quantitative study of the subject is therefore much more difficult than the qualitative or descriptive, so that the latter is too frequently adopted to the exclusion of the former. The remedy lies, I believe, in individual research into special cases and special areas where the factors involved are not too numerous, where some of them at least can be defined with some accuracy, and where, consequently, deductions can be drawn with some precision and with an accuracy which gives grounds for confidence in the result. The settlements of man, his occupations, his movements in their geographical relations are manifested everywhere, and subjects of study are to be found without difficulty, but their investigation must be based on actual observation, and on data which have been carefully collected and critically examined, so that the subject may be treated as completely as possible, and in such a way that the evidence is laid before the reader in order that he may form his own conclusions.

It is probable that some of the lack of precision which is to be found in this part of the subject is to be attributed to the want of precision in its terminology. For many things in human geography good technical terms are required, but these must be selected by those who have studied the type or phenomenon concerned and have a clear idea of the particular conditions which they desire to associate with the term; this is not the work of a committee of selection, but must grow out of the needs of the individual workers.

There is, it must be admitted, no small difficulty in using the same preciseness of

method in this portion of the subject as is readily attainable in mathematical geography, and is usually practicable in physiography; but at any rate it is undesirable to indicate any condition as the controlling one until all other possible influences have been carefully examined and have been shown to have less weight than that one which has been selected.

Whether the investigation deals with the settlements of man or his movements and means of communication it is important that in the first instance problems of a manageable size should be undertaken and thoroughly treated, leaving larger areas and wider generalizations until a sufficient stock of thoroughly reliable material which is in the form in which it can properly be used for wider aims is available.

The relation of geographical conditions to small settlements can be satisfactorily worked out if sufficient trouble is taken and all possible sources of information, both of present date and of periods which have passed away, are utilized. Such studies are of a real value and pave the way to more elaborate studies, but we need more serious study of these simpler cases both to set our facts in order and to provide a methodical classification of the conditions which prevail in this part of the subject. Out of such studies there will grow such a series of terms with well-defined associations as will give a real precision to the subject which it seems at the present time to lack.

The same benefit is to be anticipated from detailed work in relation to man's communications and the interchange of commodities in all their varied relations. Generalized and descriptive accounts are readily to be found, and these are for the most part supported by tables of statistics, all of which have their value and present truths of great importance in geography, but the spirit of active research which aims at clearing up thoroughly a small portion of the wide field of geographical activities has unequaled opportunities in the somewhat shadowy relations between the phenomena which we meet in this part of the subject, for focusing the facts better, and obtaining a more exact view of the questions involved.

Where the geography of states (political geography) is concerned the same need for original investigation as a basis for generalizations may be seen. At the present time there is much said about the various boundaries of states, and in general terms the advantages and disadvantages of different boundaries under varied conditions can be stated with fair approximation to accuracy. But I do not know of many detailed examinations of these boundaries or portions of them where full information of all the factors involved can be found set out in an orderly and authoritative manner, thus forming a sure foundation for the generalized description and providing the means of verifying its correctness or revising it where necessary.

Perhaps there is really more scientific research in geography being undertaken by individuals than I have given credit for, but certainly in geographical periodicals, and in the bibliographies which are published annually, the amount shown is not large; neither is the number of authors as large as might be expected from the importance and interest of the subject and from the activity of those centers where geography is seriously taught. There seems to be no reason why individual research on true scientific lines should not be as active in geography as it is in geology, botany, zoology, or any other branch of knowledge; and, just as in these, the real advance in the subject is dependent on such investigations rather than on travels and explora-

tions in little-known lands, unless these too are carried out scientifically and by thoroughly trained observers who know the problems which there await solution, and can read the evidence which lies before them on their route.

If research in these directions is being actively prosecuted, but the appearance of its results is delayed, let us seek out the retarding causes if there be any, and increase any facilities that may be desirable to assist individual efforts.

Short technical papers of a thoroughly scientific character, such as are the outcome of serious individual research, are, of course, not suitable for those meetings of geographical societies where the majority of the fellows present are not scientific geographers, but should be presented to small meetings of other workers in the same or allied fields, where they can be completely criticized. The reading, discussion and the publication of papers of this class are for geography a great desideratum, for it is in them and by them that all real advance in the subject is made, rather than by tales of travel, however interesting, if these are not the work of one trained in the subject, having a knowledge of what he should observe, and of what his predecessors have done in the same field. The regional aspect of geography in the hands of its best exponents has given to young geographers a wide and comprehensive outlook on the interaction of the various geographical factors in a region, the responses between the earth's surface and the life upon it, and the control that one factor may exercise upon another. In this form the fascination of geographical study is apparent to every one, but I sometimes wonder whether the exposition of such a regional study by one who is thoroughly master of the component factors, having a first-hand knowledge of all the material involved, and knowing exactly the reliability of each portion, impresses sufficiently upon the student the necessity of personal research into the details of some problem or phenomena in such a way as to gain a real working acquaintance with them; or does it on the other hand tend to encourage generalizations based on descriptive accounts which have not been verified, and where coincidences and similarities may be accepted without further inquiry as evidence of a causal connection which may not really exist? I imagine that the student may be attracted by the apparent simplicity of a masterly account of the geographical controls and responses involved, and may fail to realize that geographical descriptions, even though technically phrased, are not the equivalent of original quantitative investigation, either for his own education or as a contribution to the subject.

For these reasons I believe that societies can do far more good in the promotion of geography as a science by assisting competent investigators, by the loan of books and instruments, and by giving facilities for the discussion and publication of technical papers, than by undertaking the investigation of problems themselves.

Among the earlier presidential addresses of this section some have laid stress on the importance of the recognition by the state of geography in education; others have represented the great part which the geographical societies have played in supporting and advancing the subject; others again have urged the fuller recognition of geography by educational institutions. I would on this occasion attach especial importance to the prosecution of serious research by individuals in any branch of the subject that is accessible to them, to the discussion of the results of such work by others of like interests, and to the publication of such studies as having a real value in promoting the advancement of scientific geography.

H. G. Lyons

SOME ASPECTS OF SCIENTIFIC RESEARCH[1]

So much has been said of late on the subject of scientific research, its value to science, to the industries of the country and to the War Department, that it would seem fitting to use the first meeting of our club for a discussion of certain phases of this subject. Furthermore, research is an appropriate topic for discussion in our meetings since the Faculty Science Club was organized for the purpose of bringing each member into closer touch with the recent advances and research of the different fields of scientific endeavor.

Scientific research is, by the general public, one of the least understood and therefore least appreciated departments of science. The American people have been comparatively slow to recognize the value of the deeper and more fundamental researches in science. The national trait of desiring quick returns with a minimum expenditure of time and money has led to a certain superficial empiricism, which has gone under the garb of research. This empirical testing is even now the predominant principle in most of the so-called research laboratories of our factories and industrial plants. Even in our agricultural experiment stations, I venture to say that the major portion of the work is either routine or of the cut-and-dry type, without reference to fundamental principles.

Scientific research has perhaps as varied a meaning among scientists as ethics has in the field of law and jurisprudence. To illustrate, I might cite a paragraph from a recommendation of an applicant for the position now vacant in my department. The employer states concerning Mr. X that

> His particular work, aside from some analytical work, has been the care and conduct of the State Food Exhibit, and he has done good research work in the taking of ice-cream samples, which has been of great value to the department.

To some the term research is so comprehensive that it might properly be applied to a man's search for the best trail leading to the summit of a mountain peak, or to the prospector's investigation of the slopes of Mount Shasta. To me research means something entirely different. The personal contact with some of the leading research men of the day and an acquaintance with the writings and views of others of their type, have moulded a definite concept in my mind of the meaning of this term. To another this concept might seem erroneous, and consequently it behooves me to exercise a little charitable tolerance until I or he will have new light thrown upon the subject.

Scientific research is the slow, laborious process of laying bare, one by one, the facts and truths of nature, which have a definite bearing upon the fundamental and general principles involved in the problem. The isolation of a new chemical compound, the invention of a machine or piece of apparatus, or the discovery of a new force in nature would not necessarily be research. Only as these are units in the larger and more fundamental problem could they be included under that head. An illustration may make this point a little clearer: Some fifteen years ago Professor H. N. Morse, of Johns Hopkins University, undertook the problem of determining whether the osmotic pressure of solutions obeys the laws of Boyle, Gay Lussac and Avogadro for gases. He assumed that this could be demonstrated inside of two or three years. He learned, however, that he was unable to make or procure one satisfactory osmotic pressure cell the first year, but during that period worked out the proper clay mixtures for such cells and the methods for purifying the clays and moulding and burning the

[1] Address by the president of the Faculty Science Club of the University of Nevada, read at the opening session, September 23, 1915.

cells. The second year was occupied largely in working out and depositing a satisfactory semipermeable membrane in the cells, the third year, in making a sufficiently strong and accurate manometer and the means of joining the manometer to the cells. The following two years were required for constructing constant temperature rooms and baths where osmotic-pressure readings could be taken without temperature fluctuations in the cells. It was then five or six years from the time he started the work until he could make the first reliable set of osmotic pressure readings. During all this time Professor Morse was assisted by one or two men besides the three or four graduate students who worked with him each year. The following eight or ten years he made osmotic-pressure observations with glucose and cane sugar in water solutions at temperatures from 0 to 80 degrees.

He has finally established that the osmotic pressure of dilute solutions obeys the gas laws. Each individual unit of this great work, upon which the score or more candidates received their doctor's degree, could only be called research work when considered as a part of the general problem. Each man's contribution was of course a separate piece of original investigation.

The German army, more than any other agency, is now forcing upon the world the value of chemical research. It is the German chemists who have won the battles in Russia, Belgium and France, and the United States is now sitting up and taking notice, with the result, we hope, of finally getting the recognition that this branch of science deserves. Secretary Daniels is becoming aware of this, for he is recently reported to have said:

> The time was, that when we thought of battles, we thought of men. We were told by great leaders who had not looked into the future that the nations with the most men would win. Now it is not men, it is munitions and inventions, and to-morrow it will be neither—it will be chemistry.

The reason why the chemist has not received popular recognition like the physician, the engineer, the physicist or the geologist is that the activity of the chemist is outside the realm of comprehension of the average individual and he sees nothing imposing or spectacular with which to associate the chemist. He may admire the delicate shades of his wife's costume without considering what part the chemist had in producing them, and every day of his life he comes in contact with something or other upon which the chemist has left his finger prints.

The greatest problem confronting the profession to-day is that of getting recognition and support from the public, through its legislative bodies, but, as I mentioned before, the European war has done more than any one thing to secure the desired recognition.

The question has doubtless arisen in your minds, why it is that scientific research in Germany and other European countries occupies a higher plane than in America. To me the reason is obvious, and it is this: In Germany there is popular recognition for the research man. Everybody knows his worth to the state and to civilization. The manufacturer is especially appreciative of his work and is glad to cooperate even to his own disadvantage and loss in trying out certain processes or marketing given chemical substances whose demand may be very limited. Four out of five such ventures may be a loss to the manufacturer, but the fifth proves such a success that it overbalances the other four, and therefore if the manufacturer had not accredited the research work of the one who made the propositions, not one of the ventures would have been tried. This popular confidence in the value of chemical research has led to al-

most complete autonomy in the departments concerned.

In Germany the chief chemist is his own boss. He engages his assistants, fixes their compensation, engages and discharges janitors and laboratory helpers. He makes changes in the building and the laboratory with but nominal supervision. He apportions his funds according to his own ideas and is virtually his own administrator.

What the research man in this country needs more than anything else in order to make his work efficient, is freedom from restraint and petty annoyances. He should be made to feel that he has at least a part in the general organization and progress of the institution. Oftentimes he feels, and with a considerable degree of justification, that his department exists only by the gracious magnanimity of the administrators, whose knowledge of his work may be very limited.

Professor W. H. Walker at a joint meeting of three chemical societies in New York last winter made the following statement:

> My plea at this time is not so much for greater generosity on the part of the employer in matters of laboratory facilities, special equipment or a good library, however important these are, but rather for a larger appreciation of the conditions which make for ultimate success in research work.

In the same vein, Professor Arthur D. Little, speaking before the United States Chamber of Commerce, says:

> The plain underlying reason why we have been unable during thirty years of tariff protection to develop in this country an independent and self-contained coal tar color industry while during the same period the Germans have magnificently succeeded is to be found in the failure of our manufacturers and capitalists to realize the creative power and earning capacity of industrial research. This power and this capacity have been recognized by Germany and on them as corner stones her industries are based.

Aside from the question of recognition and support for the research man, another factor enters in, upon which the effectiveness of his work largely depends, and that factor is the time allotted to his work.

In this country there are very few independent research institutions and for that reason the major portion of scientific research is carried out in the universities and agricultural experiment stations. Everybody recognizes that teaching and research should go hand in hand and that no university professor fulfils his obligations unless he is doing some original investigation tending to advance human knowledge. This is all well and good, but are the colleges and smaller universities of the country allowing sufficient time to their professors for such work? How much creditable research could a professor carry out in the course of a year who is obliged to teach twelve to eighteen hours per week with an additional twelve or more hours in the preparation for his work? Young, enthusiastic professors have tried it over and over again, but with the same result—a stupendous failure—as far as the research goes.

The professor who has spent his energies in the classroom during the day is in no way fitted to continue his research problem in the evening, as many of them do. A neglect to observe the proper requirements for rest and relaxation will immediately tell upon the quality as well as the quantity of work produced. Consequently the college or small university can never hope to produce but an insignificant amount of research work, and this fact is recognized by President Woodward, of the Carnegie Institution at Washington, and by other administrators of research funds. It is very rare that a college professor gets a grant from such a fund, and for the very reason mentioned above.

The productive research workers in the country to-day are those who are devoting their whole time or practically their whole

time to that work. As a rule, the head professors in the larger universities are not giving more than one to five hours of lectures during the week, the rest of their time being devoted to research, while a large number of them have one or two private research assistants besides the candidates for degrees doing research work. The same is true in the European universities.

There are many other activities besides teaching that may seriously interfere with a man's productive capacity in research. The public demand for something spectacular that may be flaunted in the daily press sometimes prevails upon the scientist to forsake modest but meritorious investigation. The bid for popularity may even carry a man so far away from his department that no time at all remains for research. Furthermore, numerous cases are on record where good research men have been spoiled by promotions to official positions, so that their energies become dissipated in a mass of official detail instead of concentrated upon some one problem for solution.

Professor W. E. Castle in speaking of research establishments and the universities says:

> The attempt to combine teaching with research has another indirect but evil consequence. The periods which the professor can himself devote to research are intermittent and fragmentary. This affects disadvantageously the topics selected for investigation. They too must be minor and fragmentary. Great fundamental questions requiring long continued and uninterrupted investigation can not be attacked with any hope of success by one who has only an occasional day or a summer vacation to devote to research.

Also quoting a paragraph from Professor Woodward's report of the Carnegie Institution at Washington for last year. As regards the conditions favorable to research he says

> that fruitful research entails, in general, prolonged and arduous, if not exhaustive labor for which all of the investigator's time is none too much. Little productive work in this line may be expected from those who are absorbingly preoccupied with other affairs. Herein, as well as in other vocations, it is difficult to serve two or more exacting masters.

Another serious impediment to scientific research may be found in a too perfect organization for the handling of routine affairs connected with such work. In common parlance this perfect organization has been nicknamed "red tape." Now it sometimes happens that the red tape reels off smoothly and rapidly, but dare I say that more often it is thrown into kinks and snarls when the reeling stops. The phenomenon has doubtless been experienced to a greater or less degree by every one, but to conjure up pleasant memories, let me hypothesize as follows: *A* is a research chemist. He has discovered a new chemical compound which is rather unstable. He requires a certain chemical that will combine with the new compound and render it stable so that it can be investigated further. The requisition for the purchase of the chemical goes to *B*-check, then to *C*-check, then to *D*-check and finally to *E*-check, whereupon the chemical is ordered and within a short time delivered to *A*, greatly to his delight.

Next let us suppose that *A* is a research biologist who has just discovered a new form of marine life. He makes out a requisition for the purchase of a suitable stain or preservative and sends it to *B*. He learns, however, that *B* has gone fishing and the requisition rests. *B* returns in the course of time, checks the document and sends it to *C*. *C* has been unavoidably called away by the death of a close relative and the requisition is deposited to bide its time. Once released and checked by *C*, it is also checked at *D*, but for a good and valid reason is pigeon-holed at *E* for a few

days. The order finally goes, but when the material arrives the little stranger for whom it was intended has been dead and buried eight weeks and the discoverer *A*, whose fame might have been noised abroad in this connection, goes down to his grave untoasted, unhonored and unsung.

Any system, however perfect, that fails to provide for an emergency is worse than no system at all. As soon as a research man becomes tied down by arbitrary rules, whether they be called systems, organizations or what not, that soon his creative powers and effectiveness will be diminished. In this connection I perhaps could do no better in emphasizing my conviction than to quote a paragraph or two from Professor R. S. Lillie's Founder's Day Address at Clark University last winter.

When we look at our universities we are impressed with certain obvious peculiarities—their size, their wealth, the variety and complexity of their activities and of their organization. We may agree that size and wealth with the resources that they bring are all very well—in themselves desirable—but complexity of organization, and the practises and tendencies that go with it? Are these conducive to the intellectual life? This, in my opinion, is the critical question. So far from our taking this for granted there is good reason to believe that beyond a certain limit dependence on system and organization in institutions of learning is directly injurious to good work, and this for the simple reason that it makes for the stereotyping of activities, and hence interferes with freedom and its expression, which is originality. Such restriction, in fact, is the general purpose of organization: it aims at diminishing variation from an accepted norm. Now the more stereotyped certain things are the better; thus a railway service or a department store can not be too regular and dependable; but if our aim is not simply to repeat things that have already been done, but to discover new truth, the conditions that surround us, as well as our own temper of mind, should so far as possible encourage independent activity, and not simply that carried out in accordance with a program. In brief, purely routine activities should be subordinated in an institution of higher learning: all needless machinery should be disposed of, and the rest should be relegated to its proper place. This is a practical suggestion, and it is one of the first that I should make.

Lastly, I would like to consider a little more in detail the status of the research work in our agricultural experiment stations. Scientific work is sometimes very incorrectly and superficially judged by individuals or small groups of individuals. A meritorious piece of work may not receive immediate recognition, but will hibernate in the archives of some musty library for decades before it bounces forth in its full splendor. Nevertheless its status will soon be known, after having received due consideration by the scientists of the world.

From time to time various attempts are made to segregate and classify worthy and illustrious individuals in science, and it would be interesting to see what place the experiment station worker occupies in such segregations. From Professor Pickering's tabulation of eminent scientists (*The Popular Science Monthly*, February, 1915), it will be seen, that among the ten Americans who have been accorded the distinction of being elected foreign associates of two or more of the leading scientific societies of the world, there is no one who has been connected with an agricultural experiment station, but they are all research men who have devoted little or no time to teaching. It also appears that Norway and Sweden, with a combined population of less than eight million have produced nine scientists of the same distinction.

The Nobel Institute at Stockholm, Sweden, awards five prizes each year, three of which are for the most meritorious accomplishments in physics, chemistry and medicine. Among the forty or more who have received this recognition are two Americans, eminent research men, but neither of whom is a station man, and not

even a chemist. It should be said that only the chemists of the experiment stations would be eligible to these awards, but there are several hundred of them and a large number have now had ample time in which to establish the character of their work.

In this connection I wish to state, very emphatically, that I am not decrying all the scientific work of the stations. By no means. A great deal of it is of a high character and is becoming more and more so as time goes on. Some stations have manifested a marked improvement in the character of their work during the past four or five years, and it is to be hoped that our station will not be obliged to take a backward step. Why do you suppose our men of science in the agricultural experiment stations are not found among the fellows of the Royal Society of London or among the foreign members of the French Academy? Why is it that they are not in evidence in the Berlin Academy, or even in our own National Academy of Sciences?

The twenty-two men recently chosen on the Naval Advisory Board are essentially research men and inventors. The two men chosen by the American Chemical Society, Dr. Whitney and Dr. Baekeland are research chemists in the true sense of the word. It is obvious that the experiment station men have not yet risen to the rank entitling them to places in the notable segregations of the truly scientific men of the world. Exceptions of course must be made to the representations in "Who's Who?" and to pay-as-you-enter classifications.

There are now nearly seventeen hundred agricultural experiment-station workers in this country and their combined productivity is something enormous when quantity is considered. Their opportunities for producing genuine and fundamental research could be as great as those of the professors of the larger universities if they had the training and the concept of the deeper problems of nature and were not led astray by the tyro and dilettante who is invariably imbued with the get-rich-quick idea, although he uses the much more elegant and suggestive term "practical." The cry in the experiment stations is for something practical, not realizing that the most fundamental is the most practical in the long run.

Our stations are organized to benefit the farmer, but when we accord to the farmer the privilege of deciding what work is practical and what is not, and what problems should be undertaken and what ones should be dropped, we are committing a grave error. The pedestrian journeying along the road may properly express his opinion about the desirability of having a bridge built to span the stream but when he proposes to direct the engineer regarding the location or type of the bridge or even regarding the feasibility of having a bridge built at all, he is overstepping his bounds; but no more so than when the farmer frames the problem for the research man. Valuable suggestions regarding desired results may often be obtained from the layman, but the trained expert is the best judge whether or not the "practical" problem is practicable.

The fact that the experiment-station worker must cater to public sentiment is one of the main reasons for his failure to occupy the respected places in truly scientific circles. It is to be hoped that the farmer will acquire a greater degree of tolerance for the technical, the obscure and to him unintelligible, and when that day comes we hope that this admirable branch of science will be elevated to its proper place. Then, truly scientific men who have had the misfortune to become enmeshed in the agricultural experiment stations will

not need to be buried alive, but will stand an equal chance with their fellows in other departments of science.

The matter of training for research work has only been alluded to indirectly but I have assumed as self-evident that only the best kind of training suffices for the highest type of research. Charlatans are found in every department of science and administrators of research funds must be on their guard against their plausible but evanescent schemes. Men of this class are usually much better talkers than experimenters.

Having pointed out some of the weaknesses in research work of our agricultural experiment stations, I would like to offer a suggestion that might prove beneficial. In my opinion there is not enough expert counsel and supervision over the departmental work that is being carried on. The work in almost every field of industry is inspected and criticized, some time or other by experts efficiently trained in the departments concerned. No large engineering or construction work could proceed efficiently without expert supervision and oftentimes outside counsel and advice, and I venture to say that if this were secured for the departments of the agricultural experiment stations it would do much toward improving the character of the work and giving directors more reliable information regarding the work of their departments, in which they themselves are untrained.

It seems to me that a chemist should inspect the chemical work of a station, a botanist the botanical work, an entomologist the entomological work, and so on. The cost of inspection would thus be considerably higher than at present, but I am inclined to believe that the value to the stations would greatly overbalance this and bring departmental work up to the standard required of them. Incidentally, favorable reports from technically trained inspectors would greatly influence popular opinion concerning a given piece of work and act as a bulwark to the director in meeting outside criticism. Such inspections would also materially aid in ridding the stations of the superannuated, derelicts and driftwood which are such impediments to progress.

Another suggestion I should make is that research projects of whatever nature should be passed upon or suggested by a committee of men technically trained in the fields in which the projects are to be launched. It is not to be expected that directors and officials at Washington are competent to judge of the feasibility of a given project for research, especially when it lies outside the circumference of their own training. In my opinion such a system would result in much good to the stations and to the people at large.

To sum up, let me say that the scientific research of this country and especially of the agricultural experiment stations, has not yet reached the high standard that is possible of attainment, and that the reasons would seem to be the following: a popular disregard or lack of appreciation for research; the encroachment upon the time of the research man by teaching, outside and official work; annoyances and distractions through the business and administrative organizations; the popular demand for practical and control work rather than for the fundamentally scientific.

These unfavorable conditions could easily be remedied; and then by requiring of the research man a more thorough training, and giving him some reliable counsel, the character of his research work would unquestionably advance.

Let me close by quoting Director A. C. True's advice, which as seed, I hope, will not fall by the way side, or among thorns, or upon stony ground, but in rich black

loam where it may grow and bring forth the desired harvest. He says:

Words of friendly criticism may be as silver, but far better are golden words of encouragement.

C. Alfred Jacobson
University of Nevada

THE U. S. FISHERIES BIOLOGICAL STATION AT WOODS HOLE

The laboratory of the U. S. Fisheries Biological Station at Woods Hole, Mass., was open from June 21 to September 15 during the past summer. P. H. Mitchell, of Brown University, was director. Investigators appointed by the Bureau of Fisheries conducted the following researches bearing on the economics of the fishing industries: I. A. Field, of Clark College, the anatomy of the circulatory and nervous systems and the embryology of the edible muscle; C. W. Hahn, of the High School of Commerce, the mode of infection by, and the life history of several parasites of herring, alewives and some other food fishes; A. Kuntz, of the Washington University Medical School, with L. Radcliffe, of the U. S. Bureau of Fisheries, the identification and study of the embryological and larval stages of twelve species of common fishes; E. Linton, of Washington and Jefferson College, investigations of various fish parasites with special study of helminth and nematode parasites of butter fish, also a study of the food of winter flounders; P. H. Mitchell and W. W. Browne, of the College of City of New York, nutrition of oysters with special reference to conditions of glycogen formation; S. Morgulis, of the College of Physicians and Surgeons, the digestive enzymes of Teleosts, the changes in weight and composition of starving lobsters, a critical analysis of Moore's investigations on the metabolism of marine organisms, and a colorimetric method for approximate oxygen determinations in sea-water; G. G. Scott, of the College of the City of New York, the oxygen consumption of developing fishes at various stages, the oxygen consumption of 42 marine forms for comparison of rates of metabolism, the efficiency of various means of aerating aquaria, conditions affecting the oxygen requirements of fishes, the oxygen consumption of regenerating tissues, and the dry method of shipping live fishes; A. Thomas, of Clark University, the toxic effect of heavy metals on fishes; G. F. White, of Clark University, methods of preparing dried dogfish for human food, the distribution of nitrogen in dog fish muscle, the phosphatides of dogfish egg-oil, the collagenous matter of dogfish skulls and of tilefish swim-bladders; W. W. Browne, of the College of the City of New York, the possibilities for fish to act as carriers of pollution bacteria and the time required to rid fish of such bacteria when put in unpolluted water; B. H. Gross, the conditions affecting the occurrence of color in "green oysters"; K. S. Rice, of Brown University, the behavior of oyster spat under artificial conditions, and the methods of ridding oysters of the colored copper-containing compound found in "green oysters."

Besides the work of employees of the bureau, a number of investigations were conducted by table applicants to whom the facilities of the laboratory were extended. Such researches were as follows: R. P. Bigelow, of the Massachusetts Institute of Technology, an examination and study of 27 species of Crustacea collected by the *Albatross* during the Philippine expedition; S. R. Clemence, of the American Museum of Natural History, a survey of the reptilian and batrachian fauna of the Elizabeth Island; G. A. MacCallum, observations on fish parasites; G. H. Parker, of Harvard University, a study of reflexes and other nerve reactions of Cœlenterates; A. C. Redfield, of Harvard University, the control of chromatophores in *Fundulus* embryos, in flounders and in horned toads; E. A. Redfield, of Harvard University, the movements of shell and mantle in Lammellibranchs and the relation of such movements to respiration; I. L. Shaw, studies of diatoms; J. M. Thorrington and F. P. Reagan, of Princeton University, the development of hybrids with especial reference to the vascular system; H. C. Tracy, of Marquette University, the relation of the swim-bladder to the ear and the eighth nerve in *clupeidæ*; G. B. Wislocki, of Johns Hopkins University, the internal secretions of fishes.

THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE arrangements for the Columbus meeting of the American Association for the Advancement of Science are taking definite shape and a large attendance and an interesting program are certain.

The following affiliated societies have already indicated their intention of meeting at Columbus at the same time:

American Society of Naturalists.
American Society of Zoologists.
American Physical Society.
Botanical Society of America.
Botanists of the Central States.
American Phytopathological Society.
Entomological Society of America.
American Association of Economic Entomologists.
American Mathematical Society (Chicago Branch).
American Nature-Study Society.
American Microscopical Society.
Society for Horticultural Science.
Association of Official Seed Analysts of America.
American Federation of Teachers of the Mathematical and the Natural Sciences.
The School Garden Association of America.

Some slight conflict, owing to the fact that the committee, designated to take charge of the Second Pan-American Scientific Congress to be held in Washington, without consultation with the officers of the American Association for the Advancement of Science or, apparently, with other well-posted scientific men in this country, changed the date of the Congress from October, 1915, to December 27, 1915–January 8, 1916, thus occupying a large part of the time already set aside for the meetings of many national scientific organizations, nearly all of which are to meet elsewhere than in Washington.

The group of economic and historical societies have met this unfortunate situation by changing their plans to meet in Washington. Their sessions are to be held during the first week of the Congress. The American Association for the Advancement of Science and its affiliated societies, however, owing to the fact that the Congress is to be devoted very largely to economic subjects, have seen no reason to alter their plans and will carry forward the Columbus meeting which every indication shows will be eminently successful.

The authorities of the congress, however, are anxious to secure some degree of cooperation from the American Association for the Advancement of Science and its affiliated societies and have extended an invitation to these organizations to come to Washington at the conclusion of the Columbus meeting and attend the meetings of the second week of the congress (January 3–8, 1916). It has also been suggested by the assistant secretary general of the congress (Dr. G. L. Swiggett), that the association might to advantage hold an adjourned session of one day in Washington to indicate its desire to assist in welcoming the delegates from other American countries to the United States.

Whether this invitation will be accepted is a matter which can not well be decided until the Columbus meeting. That such a session of the association should be called an adjourned session from Columbus would, in a way, be discrediting the Columbus hosts of the association, since the coming meeting should be definitely known as the Columbus meeting and not as the Columbus-Washington meeting. It might, however, be arranged so that the American Association could hold a special session at Washington on some one of the dates indicated and which need not in any way detract from the success of the Columbus meeting or from the fact that the convocation week meeting of 1915–1916 shall go down to history as the Columbus meeting.

L. O. HOWARD,
Permanent Secretary

SCIENTIFIC NOTES AND NEWS

THE spring meeting of the American Chemical Society for 1916 will be held in Urbana, Illinois, April 18 to 21, inclusive. At that time the new chemical laboratory of the University of Illinois, said to be the largest in the world, will be dedicated.

MR. E. W. SWANTON has been elected president of the British Mycological Society.

PROFESSOR EBERTH, formerly professor of pathologic anatomy in Halle, discoverer of the typhoid bacillus, celebrated his eightieth birthday on September 21.

THE officers elected by the Medical Research Club of the University of Illinois for the year 1915–16 are: Dr. J. J. Moore, president, and Dr. Roy L. Moody, secretary.

DR. THEODORE MORTENSEN, curator of the National Museum at Copenhagen, is in Los Angeles conducting scientific research as a guest of the biology department of the University of Southern California.

DR. DANIEL J. MCCARTHY, professor of medical jurisprudence in the University of Pennsylvania, has returned from the American Ambulance Hospital in Paris and will make a report on the influence of the war on the nervous system and mental future of the soldiers.

MARGARET HARWOOD (Radcliffe, '07), later at Harvard Observatory until June, 1912, and since then, by annual award, astronomical fellow of the Nantucket Maria Mitchell Association, has been appointed for an indefinite term fellow of the association and director of its observatory. This year, which is the "quadrennial" provided for in the fellowship, Miss Harwood is studying at the University of California. Her new year at the Nantucket Observatory will begin June 15, 1916. A five hundred dollar Maria Mitchell fellowship for research work at Harvard Observatory will be available for the three years 1916 to 1919.

PROFESSOR H. RIES, of the department of geology, of Cornell University, will give a course of ten lectures on economic geology, at Columbia University during the first term, in the absence of Professor J. F. Kemp, who is absent on leave.

AT the November meeting of the Central Association of Science and Mathematics Teachers, Professor L. C. Karpinsky, of the University of Michigan, will give a paper on the story of algebra. After this paper an hour will be devoted to the discussion of the place of the history of mathematics in elementary science.

PROFESSOR HEINRICH O. HOFMAN, acting head of the department of mining and metallurgy at the Massachusetts Institute of Technology, addressed on October 20 the Franklin Institute in Philadelphia on "The Metallurgy of Copper."

THE opening address at the college of medicine, University of Illinois, was delivered by Dr. Wm. H. Welker, assistant professor of physiological chemistry.

IN his annual report, President Charles F. Thwing, of Western Reserve University, pays tributes to Dr. Dudley P. Allen and Dr. Hunter H. Powell, referred to as having performed distinguished services as members of the faculty of the School of Medicine. President Thwing says:

> Among the gifts included in the donation of $1,000,000 for the endowment of the School of Medicine was the sum of $40,000 given by members of this board with the request that this sum be used in some form to give aid to the work in which Dr. Powell was interested. I therefore venture to renew a recommendation made in a previous report that a fund be formally established to bear the name of Dr. Powell, of which the income shall be used for the support of the department to which he gave his life. To the $40,000 which should be thus set aside might fittingly be added at least $10,000. I also beg leave to express the hope that, in recognition of Dr. Allen's great service rendered to the cause of surgery in and through the School of Medicine, a special fund may be secured to bear his name, the income of which shall be used for research in the science of surgery, or for the support of its practise.

AT the meeting of the faculty of the Cornell University Medical College held at the College on Friday, October 15, 1915, the following memorial was read and adopted:

> Austin Flint, M.D., LL.D., professor emeritus in the Cornell University Medical College, passed away September 22, 1915, in the eightieth year of his age. A student of Claude Bernard and of Robin, he early achieved distinction. Thus, in 1862, at the age of twenty-five, he discovered a substance in human feces which he called stercorin, recognizing it as a derivative of cholesterin. This discovery was awarded honorable mention by the Institute of France. It did not receive full recognition because of an unfavorable pronounce-

ment by Hoppe-Seyler. However, in 1896, stercorin was again discovered, this time by Bondzynski, and given the name of koprosterin. To Flint, however, working with older, cruder methods, belongs the credit of having first isolated the substance in pure crystalline form. Austin Flint was one of the greatest teachers of the old school of American medicine. A forceful orator and skilled experimentalist, he was the first in this country to expound the doctrines of the French school of physiology which in his early life was at the height of its renown. Dr. Flint took pride in being of the fifth generation of noted physicians, his great-grandfather and his father having borne the name Austin Flint, a name which outlives him in a surviving son. We, the faculty of Cornell University Medical College, with which Dr. Flint was associated during ten years, hereby record our appreciation of this life and beg to tender our sympathies to his family.

AUGUSTUS JAY DU BOIS, for thirty years professor of civil engineering in the Sheffield Scientific School, Yale University, died at his home in New Haven, on October 19, at the age of sixty-six years.

THE REV. FATHER CHARLES M. CHARROPPIN, S.J., an astronomer, and formerly head of the department of science of St. Louis University, died at St. Charles, Mo., on October 17.

REV. MICHAEL J. TULLY, S.J., died on October 20, at the age of thirty-nine years, at Fordham University, New York. Father Tully had occupied the chair of chemistry in Boston College, at Holy Cross, St. Francis Xavier and Fordham University.

EDWARD A. MINCHIN, F.R.S., professor of protozoology in the University of London, has died at the age of forty-nine years.

PROFESSOR C. A. EWALD, of Berlin, distinguished for his work on diseases of the stomach, for thirty years editor of the *Berliner klinische Wochenschrift*, died on September 20, in his seventieth year.

AT the recent meeting in Manchester, as we learn from *Nature*, the general committee of the British Association unanimously adopted the following resolution, which has been forwarded to the Prime Minister, the Chancellor of the Exchequer and the Presidents of the Board of Education and of Agriculture and Fisheries: "That the British Association for the Advancement of Science, believing that the higher education of the nation is of supreme importance in the present crisis of our history, trusts that his Majesty's government will, by continuing its financial support, maintain the efficiency of teaching and research in the universities and university colleges of the United Kingdom."

THE geological department of Yale University has since 1871 graduated 50 men and 2 women with the degree of doctor of philosophy. Of these 50 are living, and all but 4 are following geology as a profession. Up to 1890 the degree was conferred upon 7, during the decade 1890–1900 upon 8, from 1900 to 1910 upon 22, and since then upon 15. Of those following the profession, 15 are professors and 6 are assistant professors or instructors in universities, 11 are geologists on the Geological Survey of Canada and 5 on the United States Geological Survey, 5 are state geologists, and 3 are curators of geological collections in public museums.

UNIVERSITY AND EDUCATIONAL NEWS

THE sum of about $400,000 has been subscribed in the University of Michigan alumni campaign for $1,000,000 with which to build and endow a home for the Michigan Union, as a memorial to Dr. James B. Angell, president emeritus.

DELAWARE COLLEGE, at Newark, has received a gift of $500,000, from a donor whose name is withheld, for the construction and maintenance of buildings.

THE contracts have been awarded for the erection of a new biological laboratory at the University of Nebraska to house the departments of botany and zoology. The building will be a memorial to the late Charles E. Bessey and will be known as "Bessey Hall." The main building will consist of three floors and a basement fifty by two hundred and thirty-five feet with a short wing at each end. Greenhouses and vivaria will be connected with the building.

The formal opening of the new chemistry building of the University of South Dakota, Vermillion, was celebrated on October 12 and 13. Professor Louis Kahlenberg, of the University of Wisconsin, delivered the address on that occasion. His subject was "The Chemical Aspects of Osmosis." He also spoke at convocation of the university on the subject "Important Factors in choosing Life's Work."

The *Journal* of the American Medical Association states that an important branch of the department of pathology in the Johns Hopkins University, to be devoted entirely to research work, will be opened within the next six weeks in the pathologic building, after Dr. William H. Welch returns from China. The rooms to be occupied in the new work have been equipped with scientific appliances and instruments costing several thousand dollars. A fund aggregating $22,000 has been raised for supporting the work for three years. In the absence of Dr. Welch, Dr. Milton C. Winternitz, his first assistant, has been directing the work.

Professor Alfred H. Lloyd, of the department of philosophy, has been appointed to succeed the late Professor Karl E. Guthe as dean of the University of Michigan Graduate School.

Dr. William G. Spiller has been elected professor of neurology in the medical school of the University of Pennsylvania, filling the vacancy made by the resignation of Dr. Charles K. Mills. Dr. Mills has been elected professor emeritus.

Dr. John C. Donaldson, recently from the Johns Hopkins Medical School and the Phipps Psychiatric Institute, has been appointed instructor in anatomy at the University of Cincinnati. Dr. Edward F. Malone has been advanced to be associate professor of anatomy in the same university.

Dr. Wesley M. Baldwin has resigned as assistant professor of anatomy from the Cornell University Medical College to accept the position of professor of anatomy at the Albany Medical College. Dr. Charles V. Morrill has been appointed instructor in anatomy and Dr. Robert Chambers, assistant in anatomy at the Cornell University Medical College.

At the Stevens Institute of Technology Mr. Samuel H. Lott, instructor in descriptive geometry and mechanical drawing has been appointed assistant professor. Mr. L. C. F. Horle, assistant in physics, and Mr. Lewis A. Belding, assistant in electrical engineering, have been made instructors.

Dr. Richard M. Holman, who received the degree of doctor of philosophy at the University of California in May, has been elected a member of the staff of botany of the University of Michigan. Before attending the University of California Dr. Holman spent two years in study at Leipzig with Dr. Pfeffer. Previous to that time and after graduating from Leland Stanford Junior University he was a member of the faculty of the University of the Philippines.

Dr. Chas. O. Chambers, formerly of Peabody College, Nashville, Tenn., has taken up his work as head of the department of botany and station botanist at the Oklahoma College.

Thomas L. Patterson, for the past three years associate professor of biology and physiology in the University of Maryland, school of medicine, has assumed the duties of assistant professor of physiology in the faculty of medicine of Queen's University, Kingston, Canada.

DISCUSSION AND CORRESPONDENCE

INTERNATIONAL RULES OF ZOOLOGICAL NOMENCLATURE

To the Editor of Science: Frequent requests come to me for an English edition of the International Rules of Zoological Nomenclature, as emended to date.

The Rules in question are published in the following places:

English: Proceedings of the Ninth International Congress on Zoology, held at Monaco, March, 1913, published by the Imprimerie Oberthur, Rennes, France, 1914.

French: By Maurice Cossmann (*Revue Critique de Paléozoologie*), 110 Faubourg Poissonnière, Paris, France, 1914. Price 5 francs.

Italian: Regole Internationali della Nomenclatura Zoologica. Translated by Professor F. S. Monticelli, and published by Luigi Niccolai, Florence, Italy, 1914. Price 5 lira.

Several unsuccessful attempts have been made to obtain a reprint in English, but the outlook for sale has been so indefinite, or other points have arisen, so that publishers have not been inclined to undertake the work as a business venture. Finally, in order to make it possible for zoologists to obtain a copy of the rules to date, arrangements have been made for a mimeographed edition of all the rules, with cross references to the opinions, and with an appendix containing summaries of the opinions No. 1 to No. 56.

This mimeographed edition is issued by T. O. Smallwood, 3216 N Street, Washington, D. C., price per copy 50 cents, plus 10 cents postage.

C. W. Stiles,
Secretary to Commission

GERMINATING POLLEN

To the Editor of Science: In the past, a number of requests have come in asking for the method employed by this station in determining the germinability of pollen of deciduous tree- and bush-fruits. Others who are interested in this matter will find the following method useful.

Mature pollen, either directly from the anther, or that which previously has been collected and stored, is used. Van Tieghem cells or 10 × 20 mm. moist chamber rings are fastened to ordinary microscope object slides by means of soft paraffin, employing as little as possible of the latter, and yet secure a waterproof joint. Put one or two drops of water into the cell and at two or three points about the upper edge place tiny drops of vaseline. This is better than the smearing of the entire circumference, since it serves as well to hold the cover in place and does not exclude air. Next place a small drop of the germinating medium in the center of a cover glass having a diameter somewhat greater than that of the cell. We employ 22 mm. squares. If the medium tends to spread over the glass, spread very thinly with vaseline and wipe with a dry cloth until the vaseline apparently has been removed. Sow the pollen grains evenly and sparingly over the surface of the drop by means of a needle or camel's-hair brush. If the latter is used hold it above the drop and tap lightly to scatter the pollen. Pollen may be used directly from the expanded anther by touching the latter to the germinating medium. Quickly invert the cover, place over the cell, and press it down gently, having the drop of germinating medium approximately in the center. A temperature of 22° to 25° Centigrade is best.

The germinating medium is the most important item. It may be necessary to vary its composition for the several varieties of fruits or even for the same variety, depending upon prevailing environmental conditions under which the pollen developed or has been stored.

Sometimes a 3 per cent. to 10 per cent. aqueous solution of cane sugar is entirely satisfactory. If there is considerable bursting of the pollen grains soon after sowing, increase the percentage of sugar; decrease the amount if plasmolysis takes place. Solutions should be made up fresh each day. Frequently it has been impossible to secure the optimum germination from simple sugar solutions. Most of the difficulties were avoided and excellent results obtained, when from ½ per cent. to 2 per cent. gelatin was added to the medium. The gelatine is first made up as a 4 per cent. or 8 per cent. solution. Soak the gelatin in cold water, then dissolve with the least possible heating. This solution, without sugar, will remain fit for use for several days. From this stock solution of gelatin, dilutions are readily obtained. In making up the germinating medium the diluted gelatin solution is reckoned as water and the cane sugar added directly to it. While not absolutely exact, perhaps, the method is sufficiently accurate. Thus, for a 4 per cent. solution of sugar in ½ per cent. gelatin, add one gram cane sugar to 24 c.c. of a ½ per cent. gelatin solution. Combinations of 3 per cent. to 12 per cent. cane sugar in ½ per cent. to 2 per cent. gelatin have proved very satisfactory. No definite combi-

nation can be recommended for any particular variety.

While it is generally possible to secure a higher percentage germination in the gelatin-sugar solutions than in the simple sugar solution, growth of the pollen tube is often less rapid, especially when the larger amounts of gelatin are used. This is frequently an advantage if large numbers of samples are being tested, since long, interlacing tubes make counting difficult.

E. J. Kraus

Oregon Agricultural Experiment Station

SCIENTIFIC BOOKS

Economic Geography. By John McFarlane, lecturer in geography in the University of Manchester. The Macmillan Company. 8vo. Pp. 560. $2.25.

The work is based on the principle of natural regions. It is recognized, however, that political conditions control economic development so largely that the boundaries of countries, whether natural or arbitrary, must figure in the reckoning. Also true geographic units may be closely linked into a group dominated by one or more geographic factors.

Preceding the geography of continents and countries are three chapters on physical conditions of economic activity, climate and vegetation. These chapters occupy but 26 pages and it may be questioned whether so brief and general a statement is useful as an introduction to the main treatment. The author recognizes that the economic geographer relies on the geologist, meteorologist, botanist, etc., for the data which he correlates, and it would, in the reviewer's judgment, be as well to leave the case thus; for, to take an example, a nongeologist could not derive much help from the author's two-page account of rocks and geological periods, or from one page on the principles of geomorphology, or the like brief discussions of winds, ocean currents and the distribution of plants. Should we not frankly concede that this branch of geography is an advanced phase to be based on previous training in physical and biological geography?

The proportioning of space in the regional treatment is fairly balanced considering that the text is no doubt expected to be used mainly by British students. This fact would justify 38 pages for the United Kingdom and 34 for the United States. Indeed most American texts are more one-sided than this. On the same basis we can not criticize the assignment of more space to India and Ceylon than to Germany, or giving two thirds as much space to Canada as to the United States. Our author used the term *economic* as designating the phase of anthropogeography here treated. It is not easy to see that the subject-matter differs in general scope from the volume by Mr. Chisholm, who although deeply versed in economic conditions, calls his handbook commercial geography. So, it would seem, we are still using these terms interchangeably. It is to be hoped that we may be able in time to arrive at more specific terminology.

As for the body of the work, we find sound, clearly expressed and informing accounts of the physical conditions, products and trade of the various countries, the work of a thorough and conscientious geographer. The illustrations are confined to maps, eighteen in number, mainly devoted to rainfall and the delineation of natural regions. Possibly the author's plan was deliberate, not to emphasize transportation either by map or text, and thus to justify somewhat the term economic. The chapter on the United States has been prepared with evident care. The map of natural regions conveys some misapprehensions which indeed a generalized map could not avoid. Some misleading boundaries, however, are qualified by statements in the text. Still it is not quite appropriate, as seen by an American geographer, to include the lake plains of New York and the coastal plain of New Jersey in a "Middle Appalachian Region."

The volume takes a good place among the few comprehensive manuals in English dealing with this aspect of geography.

A. P. Brigham

IO AND ITS ENVIRONMENT

The manuscript of Dr. Chas. C. Adams's paper on "The Variations and Ecological Distribution of the Snails of the Genus *Io*" was

completed more than three years ago, but has only recently been published.[1] However, little has appeared in the interim which bears directly on the subject and the author has not found it necessary to alter his original discussion.

Io is a small genus of large aquatic snails confined to the Tennessee River system and mainly to that part which lies upstream from Chattanooga. On looking over a representative collection of these shells one is immediately impressed with the great variation in their spinosity; some are absolutely smooth, and there is every intergrade from these to shells on which the spines are nearly or quite as long as the radius of the whorl. In addition there is a considerable range in the variates which one is tempted to call "ordinary"—general size of adults, globosity or shell index, color, and so forth. Adams examined chiefly the variation in shell diameter, globosity and spinosity. This he did by making careful measurements of large collections from stations throughout the range of the genus. Data for variation curves are given not only in absolute frequencies, but in "frequencies reduced to thousands" and in plotted curves. No data are given for studying correlated variation, nor has the variability of the characters been analyzed by use of the statistical methods now familiar, by reputation at least, to all students of evolution. There is probably ample justification for this omission in the fact that it is very difficult to be sure that a series is homogeneous with respect to age. At any rate, a large amount of data is offered to any enterprising biometrician who may care to tackle it, and the author seems to have gotten along fairly well, as far as he has gone, without a thorough mathematical analysis of the variability.

An inspection of the curves shows that there is a progressive change from the headwaters of the various branches of the river system downstream as follows: "From a greater diameter of the shell to less; from a high degree of globosity to one of a less degree; from a spineless to relatively long spines; from a narrow space between the spines to a wider space; and from a relatively low spine index to one of a high degree. The change from the smooth to the spinose shell is relatively abrupt, as shown by the modes, but there is a perfect series of individual intergradations." The fact that in the Holston River near Rogersville there are smooth shells where one would expect from the foregoing to find spiny ones will be referred to later.

The generally accepted belief among paleontologists concerning the phylogenetic development of spines is quoted from Beecher[2] as follows:

> The first species [of a group of animals] are small and unornamented. They increase in size, complexity and diversity, until the culmination, when most of the spinose forms begin to appear. During the decline extravagant types are apt to develop, and if the end is not yet reached, the group is continued in the small and unspecialized species which did not partake of the general tendency to spinose growth.

The author considers the possible effects of direct environmental action, hybridization and other factors as explaining the distribution of the various shell types, but there are not sufficient data at hand to reach a satisfactory conclusion. Experimental work was started but dropped because of lack of facilities. However, the orthogenetic "law of ornamentation" just quoted, taken in connection with stream history and the mixing of strains, seems to explain many of the facts.

What might be called phylogenetically young streams are rapid. In such the phylogenetically young *Io* developed, small and smooth. As time went on the streams became older, less rapid or with rapids further apart at the place where *Io* started, but the streams continued ever young at their heads where they worked back into the land mass. *Io* became phylogenetically older at its place of origin and progressed in its orthogenetic course toward

[1] Memoirs of the National Academy of Sciences, Vol. XII., Part II., Second Memoir, 1915, pp. 1–184, 61 plates.

[2] "The Origin and Significance of Spines. A Study in Evolution," Yale Bicentennial Publications, 1901, pp. 1–105.

large and spiny shells. The original type of snails followed the "young" part of the stream backward and thus there tends to be a continuous series of forms as one follows the stream. One has but to start at the headwaters and go down stream in order to see unfolded the history of both stream and shell. By the time Chattanooga is reached the stream has gotten too old, physiographically, for the snails, too deep and possibly too contaminated.

The finding of smooth shells near Rogersville in the Holston River and of spiny shells above them really fits in with this idea if we look more closely into the history of this part of the river system, for here there has been stream piracy. A young stream containing smooth shells has probably worked over into the valley of an old stream, containing spiny shells above the point of intersection, and the result is the Holston River as we now know it.

To be sure, we should like to have an explanation of the causes underlying the law of ornamentation, and also of the reason why the successively spinier snails seem to have forced their smoother relatives to migrate with the growth of the stream or to have been prevented from working up to the headwaters themselves, but we can not expect an explanation of the ultimate and Dr. Adams is to be congratulated on the progress which this paper makes in the, as yet, largely unexplored field of animal ecology.

Frank E. Lutz

THE PLIOCENE FLORAS OF HOLLAND

The study of the more immediate progenitors of the existing flora, the vast changes in distribution, and the extensive extinctions and migrations that resulted from the glaciation of the Pleistocene, as well as the evolution of recent herbaceous forms that followed in its wake, constitutes a field of endeavor that not only appeals to the imagination, but one that offers much to botany and much that is useful in reconstructing the geography, climate and history of the late Tertiary and the Quaternary. For thirty-odd years Clement Reid has been engaged in the study of the Pliocene and Pleistocene deposits of Britain and their contained floras. Some years ago with the assistance of Eleanor M. Reid he described the upper Pliocene flora of Tegelen in Holland,[1] and recently these authors have published the results of an elaborate study of similar remains from a slightly older horizon collected from the brick-clays of Reuver, Swalmen and Brunssum along the Dutch-Prussian border.[2]

This study is not only a significant contribution to the botany of the Pliocene, but it furnishes data of great importance to historical geology. With the shallowing of the Diestian or perhaps the Scaldisian sea, the delta of the combined Rhine and Meuse extended a long distance to the northwest as it did at several subsequent times during its history, as is proven by the Rhine gravels in the Cromer beds of Norfolk, and by the mammalian fauna and peat of the Dogger Bank. Remains of the middle Pliocene high-level terraces, much faulted, occur to the south and east of the Limburg plain, where the brick clays are exposed in the scarp facing that plain. The materials were collected by W. Jongmans of Leiden and P. Tesch of the Geological Institute for the exploration of the Netherlands. The Reids expended all of their efforts on the remains of fruits and seeds which they laboriously picked out of the washings of an enormous amount of material.

In the less lignitic loams lying immediately below the horizon reported upon, impressions of leaves occur and these were studied some

[1] Reid, C., and E. M., "The Fossil Flora of Tegelen-sur-Meuse, near Venloo, in the Province of Limburg," *Verhandl. Kon. Akad. Wetensch.* (Tweede Sectie), Deel XIII., No. 6, 1907; "On *Dulichium vespiforme* sp. nov. from the Brick-earth of Tegelen," *Verslag. Kon. Akad. Wetensch. Amsterdam*, 1908, p. 898; "A Further Investigation of the Pliocene Flora of Tegelen," *Ibidem*, 1910, pp. 192–199.

[2] Reid, C., and E. M., "Preliminary Note on the Fossil Plants from Reuver, Brunssum and Swalmen," *Tijdsch. Kon. Ned. Aardrijks. Genootschap*, 2e ser., Deel XXVIII., afl. 4, 1911, pp. 645–647; "The Pliocene Floras of the Dutch-Prussian Border," *Mededeelingen Rijksopsporing van Delfstoffen*, No. 6, The Hague, 1915, 178 pp., 4 tf., 20 pls.

years ago by L. Laurent of Marseilles.[3] His determination included ten dicotyledons and one conifer and indicated a similar age to that indicated by the overlying seed and fruit flora. The latter is remarkable in including nearly three hundred species, of which the botanical position of about 77 per cent. is determined with considerable certainty. This flora is shown to present a striking similarity to the living flora of the uplands of western China and to its more or less allied geographical provinces, *i. e.*, Japan, the Himalayas, eastern Tibet and the Malay Peninsula. A more remote relationship is shown with the existing flora of Europe or the Caucasus, and a still more remote relationship with the existing flora of North America.

This oriental character is shown by the presence in Limburg of forms like *Gnetum scandens, Zelkowa keaki, Pyrularia edulis, Magnolia kobus, Prunus maximowiczii, Stewartia pseudo-camellia,* etc., no longer natives of Europe, as well as by representatives of genera such as *Meliosma, Actinidia, Corylopsis, Camptotheca,* etc., not found in the existing European flora, but represented by closely allied species in China. Even when the genus is still a member of the European flora, the fossil species appears to be closer to the existing Asiatic rather than the existing European representative, as, for example, in the genera *Pterocarya, Styrax, Betula, Cornus, Clematis, Eupatorium,* etc. There are, however, among the fossils a number of large-seeded forms that are still represented in the flora of Europe, among which may be mentioned *Picea excelsa, Quercus robur, Carpinus betulus, Corylus avellana, Prunus speciosa, Ilex aquifolium, Vitis vinifera* and *Fagus* cf. *silvatica*.

The Reuverian flora, as it has been called, appears to indicate a climate about like that of southern France of the present time, but with a more abundant rainfall. It was richer in species than the present flora of Central Europe and the number of arborescent forms was greater, both relatively and absolutely, comprising fifty per cent. of the determined forms. This and other conclusions which are deduced from the present study are well known to paleobotanists, but seem to require constant reiteration to get a hearing with botanists or geologists.

The authors' explanation of events is in brief an immigration of this rich and varied warm temperate flora into the Dutch region [a survival in this region as a part of the rich and more or less cosmopolitan flora of the earlier Tertiary is probably a better way of stating the case], where with the progressive lowering of temperatures in the late Pliocene as is indicated by the floras of Tegelen near Venloo, Wylerberg near Nijmwegen and the Cromer Forest bed, it found its retreat to the southward cut off by mountains, seas or deserts, from the Pyrenees on the west eastward all of the way to Tibet, so that all but a few forms like *Quercus robur, Corylus avellana* and *Picea excelsa* were subsequently exterminated. Even those forms that succeeded in reaching the shores of the Mediterranean seem to have found themselves in a climate that was too dry.

Compared with Europe both North America and eastern Asia afforded better facilities for a continuous movement of plants to the southward and back—North America with its mountains trending north and south, with the broad valley of the Mississippi and the well-watered Atlantic coastal plain—eastern Asia with the coastal plain of China and the great river-valley systems of that country. Recolonization from the southward in post-glacial Europe was a slow process and these are two of the reasons why the existing Asiatic flora or that of eastern North America is so much richer than that of Europe.

Among botanical items that I have not yet mentioned are species of *Ardisia, Mæsa, Liriodendron, Cinnamomum, Hakea, Mimusops, Diospyros,* stones of a *Nyssa* indistinguishable from our American *sylvatica,* as well as many others that might be enumerated. It must make the shade of Bentham turn over to have an Englishman identify the fruits of Proteaceæ in Europe.

All of the material is carpological, *i. e.*, the

[3] In Jongmans, W., "Rapport over zijne paleobot," *Rijksopsporing van Delfstoffen,* Jahren, 1908–11, pp. 23–25.

remains of fruits and seeds, which is supposed to be more certainly determinable than leaf impressions. It has been laboriously compared with recent material in the Kew herbarium and from other sources and is illustrated by enlarged photographs often showing the recent seed by the side of the fossil. One is impressed with the care with which the work has been done and the authors certainly merit the gratitude of their confrères. I venture to hope that they will feel called upon to give us the benefit of their experience in instituting a comparison, confessedly difficult, between their Pliocene fruit and seed floras of Reuver, Tegelen, Cromer, etc., and the abundant Pliocene floras represented by leaves in France, Italy and throughout southeastern Europe.

Edward W. Berry
Johns Hopkins University,
Baltimore, Md.

SPECIAL ARTICLES

THE MEASUREMENT OF OXIDATION IN THE SEA-URCHIN EGG

Because of its accuracy and convenience, Winkler's method of determining the amount of oxygen in solution has been almost exclusively used in the various studies of oxygen consumption of sea-urchin eggs. This method, as described in various texts of quantitative analysis, depends upon a chain of reactions, which result finally in the liberation of two atoms of iodine for each atom of oxygen originally present in solution. The investigator of egg oxidations measures the oxygen content of some sea-water before and after eggs have been contained in it. The usual procedure appears to be about as follows: The eggs are enclosed in a 300 c.c. bottle filled with sea-water and tightly sealed. At the conclusion of a certain time interval (usually an hour), the supernatant sea-water is siphoned off into a 250 c.c. bottle and tested for oxygen. From the value thus obtained, the oxygen concentration in the 300 c.c. bottle at the conclusion of the experiment can be computed, and thus if the original oxygen content of the sea-water is known, the amount of oxygen consumption is readily obtained by subtraction.

It is obvious that the ordinary Winkler method of determining oxygen loses its efficiency in the presence of any substance which takes up iodine. Now it is a fact that iodine absorbing substances are actually present in sea-water which has stood over sea-urchin eggs. This can best be shown by actual measurement of the iodine absorption of such "egg sea-water."[1] These measurements have been made a number of times. They show a small but quite constant value.

Of course after the eggs have been treated with any cytolytic agent, they give off to the sea-water very much larger quantities of iodine-absorbing substances.

Analytical chemists have suggested at least two methods of making Winkler determinations in the presence of organic substances. Perhaps the Rideal and Stewart method is the one most often used.[2] In this method the organic substances are oxidized by potassium permanganate in the presence of sulphuric acid. This method may do very well for most organic substances, but in order to oxidize proteins completely, hot concentrated permanganate solutions are necessary, and the dilute solutions recommended by Rideal and Stewart can accomplish but very little in the way of oxidations. The extensive literature on the oxidation of proteins by permanganate solutions can not be referred to here; the reader will find many references in Oppenheimer's "Handbuch der Biochemie."[3] In actual practise the Rideal and Stewart method has not proved satisfactory.

Another method is to determine the iodine-absorbing powers of the water which contains organic matter.[4] In this way a correction is obtained which is added to the value determined by the ordinary Winkler method. In measuring egg oxidations, this method is open to the objection that the sample chosen for the correction may not be truly representative of

[1] *I. e.*, sea-water which has stood over eggs.

[2] Rideal and Stewart, *Analyst*, XXVI., 141, 1901.

[3] Vol. 1, pp. 489–495.

[4] *Cf.* Lunge, "Technical Methods of Chemical Analysis," New York, 1908, Vol. 1, Part II., p. 783.

the entire volume of "egg sea-water." The presence of eggs at the bottom of the bottle makes impossible the thorough mixing which should precede the taking of a sample.

Sea-water which has stood over eggs in shallow beakers exposed to the air always gives much lower values for oxygen content than ordinary sea-water at the same temperature. The difference is of the same order of magnitude as the amount of oxygen used by the eggs in an hour. But it is not due to oxygen consumption, for the "egg sea-water" may be siphoned off and allowed to remain several hours in contact with air, so that equilibrium is certainly established. The difference is of course in part due to the iodine absorption of "egg sea-water," but not wholly so. For if we test a representative sample and obtain the necessary correction for iodine absorption, a difference still remains. If we assume that our method is accurate, we are led to the conclusion that the solubility of oxygen in sea-water is lowered by some substance or substances secreted by, or dissolved away from the eggs. This is not at all unusual, if we remember that Findlay and his collaborators have shown that many colloidal substances exert a well-marked influence on the solubility of gases.[5] Granted that our conclusion is correct, no method of measuring oxidations that depends on a change of oxygen tension (*e. g.*, the Warburg-Siebeck method[6]) is accurate. For any such method assumes that the oxygen solubility of the sea-water remains constant.

Another method of making determinations was devised in the summer of 1914. It was found that the iodine-absorbing substances normally given off by *Arbacia* eggs are colloidal. They do not diffuse through celloidin or parchment membranes. In the measurement of egg oxidations, therefore, the eggs may be enclosed in celloidin tubes instead of being allowed to lie free in the sea-water. Tubes of about 10 c.c. capacity and of narrow bore fit nicely into 300 c.c. bottles. At the conclusion of an experiment, the tube containing eggs is taken out, the bottle is filled to the top with sea-water of known oxygen content and is tested for oxygen by the Winkler method. The use of the celloidin tube has another advantage, in that oxygen determinations may be made in the same bottle in which the eggs were kept. Thus, siphoning is unnecessary and there is no error from this source. The tube method is, however, open to the objection that in the case of sea-urchin eggs at least, development can not take place if the eggs are too closely packed. Without modification it can therefore not be used for the measurement of oxidations during cleavage.

Determinations have been made both by this tube method and by adding corrections for iodine absorption. The results gained so far are not sufficiently accurate to warrant publication. They do show, however, that partial or complete cytolysis produced by dilute sea-water causes not an increase, but a decrease of oxidations.[7]

L. V. Heilbrunn

Woods Hole, Mass.,
July 26, 1915

[5] *Jour. Chem. Soc. Trans.*, XCVII., 536, 1910; CI., 1,459, 1912; CIII., 636, 1913; CV., 291, 1914.

[6] O. Warburg, *Zeit. f. physiol. Chemie*, XCII., 231, 1914.

[7] The tube method can not be used for completely cytolyzed eggs, as the egg pigment wanders through the walls of the celloidin tubes.

A BACTERIAL DISEASE OF WESTERN WHEAT-GRASS. FIRST ACCOUNT OF THE OCCURRENCE OF A NEW TYPE OF BACTERIAL DISEASE IN AMERICA

A very unusual type of bacterial disease has been found occurring on western wheat-grass, *Agropyron smithii* Rydb., in the Salt Lake Valley, Utah, and has been given considerable study by the writer during the current season. Although affected plants are usually somewhat dwarfed, the most striking characteristic of the disease is the presence of enormous masses of surface bacteria which form a lemon-yellow ooze or slime. Sometimes this bacterial slime appears in small droplets, but very often it is spread over the surface of the upper portion of the plant including the sheath, upper internode and inflorescence. The glumes which are badly attacked reveal bacterial layers of slime

between them. Sections of the spikelets show that the floral organs are extensively occupied by the bacterial organism which may be found filling the spaces between them. The disease seems to be that of the upper portion of the plant and has not been found on the roots or lower internodes and sheaths. There is produced a premature drying and bleaching of all the parts of the plant covered by the bacterial ooze. When the bacterial slime hardens it may be separated from the plant surface in the form of thin, lemon-yellow flakes.

At room temperature (25° C. ±) the organism grows very slowly on nutrient neutral agar. Plates that were thickly sown did not begin to show growth until the eighth day, while very thinly sown plates produced no bacterial colonies. However, the organism grows promptly on cooked potato, producing a viscid, lemon-yellow growth at the end of about the sixth day, but growth is apparent by the end of the second day. Organisms taken from a two-day cooked potato culture and stained with carbol-fuchsin, are about twice as long as broad and occur singly or in pairs joined end to end. A white organism which grows readily in agar is frequently found associated with the yellow organism.

This disease of western wheat-grass has many characteristics in common with Ráthay's disease of orchard grass (*Dactylis glomerata*, L.) caused by *Aplanobacter ráthayi*, E. F. S., and described by Ráthay[1] and later by Smith.[2]

First: The characteristic viscid, lemon-yellow slime forming layers over the uppermost leaves, the upper internodes and the different parts of the inflorescence is common in both diseases.

Second: The injury to the plants is due to the bacterial growth which first develops conspicuously on the surface and only later penetrates into the interior.

Third: The bacterial organism in both diseases produces a characteristic lemon-yellow growth.

Fourth: The best growth is made upon cooked potato; growth on agar is very slow and unless the organism is thickly sown growth does not readily take place.

Fifth: A white organism which readily grows on agar is frequently associated with the yellow organism in both diseases.

An extended study of the disease and the causative organism is in progress and the results will be published later.

P. J. O'GARA

DEPARTMENT OF AGRICULTURAL INVESTIGATIONS,
AMERICAN SMELTING & REFINING COMPANY,
SALT LAKE CITY, UTAH,
July 13, 1915

[1] Ráthay, Emerich, "Ueber eine Bakteriose von *Dactylis glomerata* L.," *Sitzber. der Wiener Akad.*, 1 Abth., Bd. CVIII., pp. 597–602, 1889.

[2] Smith, Erwin F., "A New Type of Bacterial Disease," SCIENCE, N. S., Vol. XXXVIII., No. 991, Dec. 26, 1913. "Bacteria in Relation to Plant Diseases," Vol. III., August 4, 1914.

REPORT OF THE SAN FRANCISCO MEETINGS OF SECTION F OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE opening session was held on Monday morning, August second, in San Francisco, in joint meeting with all other sections to listen to addresses of welcome and the address of the president of the Pacific Coast Division of the American Association for the Advancement of Science, Dr. W. W. Campbell.

In the afternoon, the Section adjourned to the University of California, Berkeley, where, in conjunction with the American Society of Naturalists and the American Society of Zoologists, the following papers were read.

On Wednesday, August 4, the affiliated societies made an excursion to Stanford University, at Palo Alto, and in the afternoon held a joint session with the American Genetic Association and the Eugenics Research Association.

The program for the San Francisco meetings was arranged by the following committee:

COMMITTEE ON PROGRAM

Charles A. Kofoid, chairman, University of California; Barton W. Evermann, California Academy of Sciences, San Francisco; C. H. Gilbert, Stanford University; Joseph Grinnell, University of California; S. J. Holmes, University of California; Vernon L. Kellogg, Stanford University; William E. Ritter, University of California; Harry Beal Torrey, Reed College, Portland.

JOHN F. BOVARD,
Acting Secretary for Section F

PROGRAM

Monday, August 2

Afternoon Session, Demonstrations

In charge of W. P. Taylor, University of California

Pacific Coast Crabs, F. W. Weymouth, Stanford University.

Papers: Conservation

Barton W. Evermann, California Academy of Sciences, San Francisco, presiding

Opening Address, Charles A. Kofoid, University of California, acting vice-president, Section F, Zoology.

Conservation and Utilization of our Fur Seals (illustrated with lantern slides): George Archibald Clark, Stanford University.

The paper pointed out the importance of the herd which has yielded twenty-six millions in revenue to the treasury since transfer from Russia in 1867. The seal herd was shown to be reduced to-day to one tenth its original size, with corresponding decrease of revenue. Two pertinent features of the natural history of the seals were discussed; first, the polygamous habit, on which land sealing, the removing of the surplus males—as in case of domestic animals—was based and conducted without injury to herd; second, the distant feeding and migration habit, which take the animals constantly outside the ordinary territorial jurisdiction and down in the Pacific to the latitude of Southern California each winter. The decline of the herd was shown to be due to indiscriminate hunting in the open sea, involving the death of gravid and nursing females with their offspring. This form of hunting was stopped after thirty-two years by treaty with Great Britain, Russia and Japan, signed in 1911, in which the United States pledged a share of its land catch of males to Canada and Japan in return for abandonment by their citizens of pelagic hunting. Congress in 1912 in enacting law to give effect to this treaty suspended land sealing also, cutting off vital consideration and jeopardizing the treaty, also involving half-million dollar annual loss and future detriment to herd through overstock of males. A review of government management showed mistakes and apparent inability to deal effectively with problem; marked by inefficiency of transient politically appointed agents and failure to utilize scientific investigations when made at intervals. The need of systematic and persistent expert care and study was shown to be imperative. Management through Treasury Department first and later by Department of Commerce both marked by failure. Transfer urged to Department of Agriculture, which in its biological survey and division of animal industry has experts and facilities necessary to deal with herd, whose problems are analogous to those of sheep, cattle, etc.

Condition of the American Seal Herd in 1914 (motion pictures of the fur seal): W. H. Osgood, United States Biological Survey.

A census of the American herd of fur-seals on the Pribilof Islands in 1914 shows in round numbers 295,000 seals, of which 93,250 are breeding females. This is an increase from 268,000 in 1913 and 215,000 in 1912, or nearly forty per cent. in two years. Although there are other considerations, this increase is due mainly to the treaty of 1911 by which pelagic sealing was stopped. The total number of animals is not large as compared with upwards of 2,000,000 which the herd once contained, but actually it is by no means small and it is reasonable to hope that with proper management a nearly or quite complete regeneration of the herd may be effected.

A very large proportion of the increase consists of young male seals and these, if permitted to come to maturity, will soon produce a large overstock of males of breeding age. This increase and the impending surplus of male life are due principally to a limitation of land killing imposed by a law passed by the congress of the United States in 1912. It has been and may well be contended that this law should not have been enacted. Whether or not the law at the time it was passed had any features deserving support (and this is of no present importance) it is evident that the restrictions imposed by it are now both unnecessary and harmful. That it should be radically changed or entirely repealed is so plain as to be scarcely open to argument.

Motion pictures taken in 1914 illustrate the peculiarities of seals of different classes, their appearance and habits, and sufficiently demonstrate in an incontrovertible way that the seal herd is not, as many suppose, on the verge of extinction. They show also the methods of enumerating seals, of driving, branding, killing and of taking and preserving skins.

The Recent History and Present Status of some Game and Fur-bearing Mammals of California: Walter P. Taylor, curator of mammals, Museum of Vertebrate Zoology, University of California.

The present condition of the native animals of the world is such that the preservation of representative faunas is coming to be one of the important concerns both of zoologists and of governments in widely separated localities. California's list of mammals aggregates 369 species and subspecies, as compared with 80 for Kansas, 94 for Nebraska, 152 for Colorado and 182 for Texas. An examination of the recent history and present status of California's fur-bearing and game mammals, including the beaver, sea elephant, sea otter, deer, elk, mountain sheep, pronghorned antelope, black and grizzly bears, serves to justify according her a place among the important big game countries of the world. There has been a steady decrease in the original supply of wild life of the state dating from the beginning of the nineteenth century. It is coming to be realized that, particularly in a democracy, a special obligation to furnish leadership in movements for the perpetuation of the native fauna rests upon the professional zoologist.

The Administration of Fish and Game Laws: ERNEST SCHAEFFLE, executive officer of the California Fish and Game Commission.

Mr. Schaeffle declared that in California the administration of the fish and game laws during the last twenty years has been made easier through the support of public opinion and the fact that to the violation of the laws is attached a good deal of the same obloquy that attends the commission of larcenies and other unpopular misdemeanors. He denied the claim that California could have on sale the same quantity of game as Great Britain if the British system were followed and that the British system is better for both game and man. Moreover, he pointed out that the limiting of shooting to the aristocracy, even if it is a protection of a sort to the game, is un-American and besides that undesirable.

"In this country we feel that it is not only right but wise that man's instinct for sport be kept alive; would not certain European nations be better off in this crisis if their common people —boys and men—had been permitted to hunt, fish, learn to camp out—and to handle arms? We think so—and further, we think that a state or country where the average man knows how to shoot is safer, in times of peace and war, than those countries which are obliged to depend upon conscript armies of men whose experience with firearms is limited practically to the dismounting, assembling and polishing of their weapons."

One reason why fish and game laws are more cheerfully obeyed now, Mr. Schaeffle said, is that the laws that are framed now are based on knowledge and common sense and sensibly administered.

The Need of Scientific Research in Salmon Conservation: JOHN PEARL BABCOCK, commissioner of fisheries, Victoria, B. C.

It has been supposed that the key to fish conservation is found in artificial propagation, whereby the percentage of egg fertilization is increased, but this has not been proven. Examination of large runs after planting do not show evidence of man's assistance. Feeding in later stages is not well understood and has not been successful. Propagation concerns but a fraction of the fish's life history and even this portion has not been thoroughly investigated. Too much money has been expended on propagatory work and too little on the necessary scientific investigation which should precede such work. [Read by Barton W. Evermann.]

The Crab Problem of the Pacific Coast: F. W. WEYMOUTH, Stanford University.

Cancer magister, the edible crab of the Pacific coast, is found from Unalaska to Lower California in shallow water. It frequents sandy bottoms, feeding chiefly on small fish and crustaceans. The females lay in the fall from three quarters to one and a half million eggs, which are carried attached to the abdominal legs until they hatch three or four months later. The larvæ are free swimming for about four months, but on molting to the adult form in the summer, seek the bottom and take on essentially the habits of the adult.

The principal fisheries are at San Francisco and Eureka in California, Dungeness, Anacortes and Neah Bay in Washington and Boundary Bay and Prince Rupert in British Columbia. Fishing is carried on in shallow sheltered bays by traps similar to lobster pots, and on exposed bars or limited coves by means of hoop nets.

The edible crab was once extremely abundant through most of its range, but has been markedly reduced in such old and heavily fished localities as San Francisco, in spite of protective legislation. We see in the lobster fishery that neither abundance nor wide distribution has prevented depletion under persistent fishing, and that to-day the lobster is hardly holding his own though protected by stringent laws and aided by artificial hatching. It is much easier to conserve an existing fishery than to replace an exhausted one. We should, therefore, anticipate the future heavy fishing in still unexploited regions with laws designed

not for to-day, but for the conditions we soon must face. The following regulations, at present in force to varying extents in different districts, are recommended for the entire coast:

1. A size limit of 6½ and preferably 7 inches, to be strictly enforced.
2. Complete protection of the females.
3. A closed season of three or more months covering the season, varying with the locality, during which soft crabs are taken.

Conservation of the California Elk: Barton W. Evermann (read by title).

Tuesday, August 3

Morning Session, Demonstration

In charge of J. Frank Daniel, University of California

Improved Hydrogen Electrodes and Methods of Using Them, J. F. McClendon, University of Minnesota.

Papers: General Zoology

S. J. Holmes, University of California, presiding

The Importance of Description and Classification in Philosophical Biology and in Education: W. E. Ritter, Scripps Institution for Biological Research, La Jolla.

The Physiological Analysis of Behavior: H. B. Torrey, Reed College, Portland.

Problems Concerning the Relation between Germ Cells and their Environment: Bennet M. Allen, University of Kansas, Lawrence, Kansas.

There is an increasing body of evidence to show that the germ-cells may be influenced by the environment. These influences may strike deep—injuring the germ-plasm so greatly as to produce abnormal development. They may bring about the appearance of mutants, as shown by Tower, MacDougal, Gager and others. In some forms the external influences upon the germ-cells produce only evanescent changes lasting but a few generations at the most. In still other cases they may merely serve to determine dominance in heredity. Sex determination in some forms at least appears to be brought about by these factors. The organism must be able to resist influences of the environment that are frequently met with in their normal life, otherwise animals and plants would be far more unstable than we find them to be.

Much needs to be done in studying the factors that govern the rhythm of germ-cell production, the increased or decreased fertility due to change of external factors such as climate, social life, etc., and the effects of domestication upon reproduction.

The recent marked increase in our knowledge of the glands of internal secretion shows how far-reaching may be their influence upon the organism as a whole. These and other substances present in minute quantities in the blood may well exert powerful influences upon the germ-cells.

Giant Fiber Action and Normal Transmission by the Nerve Cord of Earthworms: John F. Bovard, University of Oregon.

The peripheral nerves in a certain number of segments of an earthworm may be anesthetized and the nervous impulses responsible for locomotion will travel through the cord in the affected region. The distance which these impulses will pass without any reenforcement from muscular contractions is limited to about twenty ganglia. The rate at which these impulses are transmitted is a slow one and is about 22 mm. per second.

The giant fibers are not concerned directly with the locomotion, but with contractions of the longitudinal muscles in quick end-to-end movements. The speed of transmissions in these larger fibers is very rapid, 1,500 mm. per second. In regeneration from simple traverse section of the nerve cord, the recovery is very rapid, and the locomotor fibers resume activity before the giant fibers. When short pieces of the nerve cord are removed, recovery is much slower, but the order in which fibers transmit impulses again is the same as in simpler sections.

Drugs, such as stovaine, when applied to the cord show the same relations as in regeneration. The locomotor fibers recover first and the giant fibers later.

Afternoon Session, Papers: General Zoology

Trevor Kincaid, University of Washington, presiding

The Action of Simple Reagents on Nerve Cells: W. A. Hilton, Pomona College, Claremont, California.

In order to learn something further in regard to the physical constitution of nerve cells, simple solutions which might act in various ways were used. In some cases the nervous tissues were treated directly with the reagent; in others the ganglia, or parts of the brain, were placed in boiling water first. Similar results were obtained by both methods. Acids, alkalies and other powerful reagents were used with the result that in almost every case a fibular groundwork for both

nucleus and cell body was revealed. A similar, but less dense perinuclear arrangement of fibrils was shown in nearly every case. Experiments with vertebrates and arthropods gave somewhat similar results, although the position of the cells and the surrounding parts differ. Living tissues were examined as a check, and by comparison the reticular arrangements of fibrils between and in cells were regarded as artifacts in most cases. Osmic acid gave the least distortion of any single reagent.

Observation on the Laws of the Correlation of Parts: J. C. Merriam, University of California (read by title).

Provision for the Study of the Anthropoid Apes: Robert M. Yerkes, Harvard University.

It is doubtful whether there is any group of organisms of greater importance for biological study than the Anthropoidea. Nevertheless, our ignorance of most representatives of this suborder is more impressive than our knowledge. Of the anatomy, histology, embryology we know much, far from all; of the pathology, physiology and behavior of the apes, baboons and monkeys we know pitiably little: of their psychology and sociology, even less.

Surely it is high time to make provision for the thorough biological study of those organisms which are most similar to man and from whom, therefore, experimental pathology, genetics, psychology and the social sciences and technologies may be expected to obtain information of immeasurable theoretical and practical value.

The need of an anthropoid station is obvious. I know of only one attempt to provide facilities for the study of the apes. That has been made by the Germans in the Canary Islands. I have seen no published reports of data or progress, but through correspondence with the present worker, Dr. Wolfgang Koehler, I learn that observations have not been interrupted by the war. For reasons which may not be stated within the limits of this abstract, it seems wiser to establish an American station rather than to cooperate with the Germans.

There is abundant reason for supposing that the apes may be kept in perfect health over long periods and bred in Southern California. Hence it seems desirable to establish a station there rather than in the tropics[1] where the conditions are much less favorable for research.

[1] The possibilities of Borneo, Jamaica, Porto Rico and other tropical regions have been carefully considered.

The following plan is one which I hope may be carried out: In a suitable locality in California temporary provision might be made for the housing of sexually mature orang utans, chimpanzees and gibbons during a three-year test of the possibility of breeding. At the same time adolescent apes—and monkeys—could be studied by the staff of the station. Since my chief interest is in behavior and mind, I should wish first of all to arrange for the study of their instincts, ideational behavior and social relations. Three years of concentrated effort should add vastly to our knowledge of the behavior and psychology of the apes, as well as settle the practically important question of breeding.

If the apes, as well as the monkeys, can be bred satisfactorily in California, a permanent station should be established at which the most diverse aspects of the lives of the Anthropoidea (including man) might be studied.

Studies on Echinoderm Larvæ (illustrated with lantern slides): Th. Mortensen, University Museum, Copenhagen, Denmark.

These researches were undertaken mainly with the view of ascertaining whether there is any interrelation between the shape and structure of the larvæ and the natural relationship of the grown forms of the Echinoderms. They were carried out at the biological station at Misaki, Japan, in Australia, New Zealand, the Hawaiian Islands, and at the Biological Station, Nanaimo, B. C., during the time from May, 1914, till now.

In all the development of thirty-five different forms, mostly Echinoids, has been studied more or less completely. The results completely bear out the conclusions that the larvæ are of considerable value for classification, so that in cases of doubt about the systematic position of some form or other, the larval characters may settle the question; *e. g.*, the genus *Strongylocentrotus.* Within the regular Echinoids distinct family characters are found in the larvæ. Thus the larvæ of the family *Echinidæ* have in their first stage the main rod of their body skeleton elongated and more or less club-shaped, while in the families *Toxopneustidæ* and *Echinometridæ* the body skeleton in the first larval stage forms a sort of frame. In the larvæ of the *Temnopleuridæ* the main rod of the body skeleton is slightly elongated, with some characteristic processes. Previously not a single larva of any Temnopleurid or Echinometrid was known; now the development of three Temno-

pleurids and seven Echinometrids has been studied. Special interest attaches to the larva of *Echinobrissa recens;* it proves to have no likeness to the Spatangoid larvæ, but more so to the Clypeastroid larvæ, from which it is mainly distinguished by the rods of its processes being non-fenestrated.

A remarkable shortened development was found to obtain in *Laganum decogonale* and in *Toxocidaris erythrogrammus.* In the former the larval shape is still distinct, although rudimentary; in the latter there is no trace of larval processes, the embryo being simply worm shaped. A similar shortened development will doubtless prove to occur in the *Schiaster* occurring in the strait of Georgia.

By the successful rearing of the larvæ of a deep-sea species, *Lagunum fudsiyama,* it has been proved for the first time that typical pelagic larvæ may be found among deep-sea forms, and the possibility of studying the embryology of deep-sea forms is shown.

In other groups of Echinoderms the results are not yet sufficient for definitely establishing family characters in the larvæ. An interesting fact is that two species of *Asterina, A. pectinifera* (Japan), and *A. regularis* (New Zealand), have been found to have typical pelagic larvæ.

Hydrogen Ion Concentration in Stomach and Duodenum: J. F. McCLENDON, University of Minnesota.

The hydrogen ion concentration of the stomachs of normal persons after normal meals was measured every half hour by means of a hydrogen electrode lowered into the stomach or by removing a small sample. The hydrogen ion concentration rises rapidly after injection of the food and reaches a constant level 1½ to 2½ hours after finishing the meal. This level varies with the individual and approaches a limit of 1/10 normal $H+$.

The hydrogen ion concentration of the duodenal contents removed with the duodenal tube is about 2×10^{-8}.

The hydrogen ion concentration of the infant's stomach rises slowly after nursing and in one hour is about 6×10^{-6}. As the stomach empties the hydrogen ion concentration rapidly rises and becomes .01 normal 4 hours after nursing. The hydrogen ion concentration of the infant's duodenum is about 8×10^{-4} or nearly a thousandth normal and is sufficient for peptic digestion. Pepsin was always present in the infant's duodenum and therefore peptic digestion goes on there.

Parthenogenesis of the Frog's Egg: J. F. McCLENDON, University of Minnesota.

In 1911 I showed that the frog's egg may be caused to segment by a momentary electric shock, which takes the place of the spermatozoon. The immediate effect of the electric shock or the spermatozoon is increase in permeability since Na, K, Li, Mg, Ca, Cl, SO_4 and CO_3 diffuse out of the egg into the surrounding water at a faster rate. By very careful estimation of the chlorides with the Richard's nephelometer it was found that twice as much diffused out of the egg that had been stimulated electrically or fertilized as out of the unfertilized egg in distilled water. This increased permeability continues for 30 hours or perhaps longer.

The increased permeability protects the egg from swelling. Bachman and Rumstrom supposed the egg was protected by absorption of proteids, but they furnish no grounds for this assumption.

The increased permeability of the sea-urchin's egg lasts fifteen minutes after stimulation or fertilization and some fish eggs are impermeable to water and salt some time after fertilization. That stimulation and increased permeability are related is supported by the fact that increase in permeability of fish eggs is prevented by anesthetics.

Wednesday, August 4, Afternoon Session

Joint session of Section F, Zoology, the American Society of Naturalists, the American Society of Zoologists, the American Genetic Association and the Eugenics Research Association.

Demonstrations

In charge of MARY I. MCCRACKEN, Stanford University

Papers: The Rôle of Variation and Heredity in Evolution

DAVID STARR JORDAN, Stanford University, presiding

Heredity and Mutation as Cell Phenomena: R. RUGGLES GATES, University of London.

Heredity consists in the perpetuation of the difference between related organisms. The older definition of heredity as the tendency of like to beget like is incomplete. Variations are divided into three classes, (1) those which are completely inherited, (2) those which are non-inherited, (3) those which are partially inherited; and these three kinds of variations must have very different evolutionary significance.

Mutations, or discontinuous variations, belong in the first class, and they are of many kinds, differing in their manner of origin and their manner of inheritance. Studies of the cell structure of mutants has made it possible to classify mutations into (1) those which are fundamentally morphological and (2) those which are primarily chemical. The hypothesis that each Mendelian character is the result of a chemical change in the nature of one chromosome in a germ cell, will account for not only the origin, but also the inheritance of every simple Mendelian character. Such a mutation is no more unlikely than mutations in bacteria, many of which are now known to occur. Each Mendelian pair of characters therefore represents a mutation which has occurred in past time.

The morphological mutations at present known consist in changes in the number of chromosomes in cell nuclei. The fundamental chromosome number in the genus *Œnothera* is 14, but *Œ. lata* has 15, *Œ. gigas* 28, etc. In these cases there has been a change in the constitution of the nucleus which may be considered to be morphological in nature. The change is propagated to every part of the organism by mitosis or cell division. Hence, for example, every cell of *Œ. lata* has 15 chromosomes, and the peculiarities of *Œ. lata* appear to result from this fact. One may conclude that each mutation, in plants at least, is a cell change originating in a particular germ cell and represented in every cell of the adult mutant organism.

The Idea of Multiple Causes as applied to Evolution: Wm. E. Ritter, Scripps Institute for Biological Research, La Jolla, California.

To be published later.

Seventeen Years' Selection of a Character Showing Mendelian Inheritance: Raymond Pearl, Maine Agricultural Experiment Station, Orono (read by title).

Are there such Things as Unit Characters? S. J. Holmes, University of California.

The doctrine that organisms are mosaics of independently varying elements is one that has figured largely in biological speculation from Darwin's time to the present. It is very intimately associated with many problems of heredity and evolution, and one is very liable to think in terms of the doctrine and unconsciously allow it to shape his opinions even though he may not avow his adherence to it. The doctrine is founded on the assumed independent variability of parts and the independent transmission of so-called characters. Many facts pointing to independent variability have been amassed by Darwin, De Vries and Weismann, and the latter has argued with especial force that it is impossible for several organs to be simultaneously perfected unless variations in the one occur independently of variations in the others. On the other hand, it may be pointed out that numerous variations have far-reaching correlations and that often a variation may be particularly manifest in some one feature, but nevertheless be the result of a general organic change which is only obscurely expressed in other parts of the organisms.

Mendelian inheritance which seems to lend support to the conception of the organism as a mosaic product is open to a quite different interpretation if we assume that what are segregated are not the bearers of unit characters merely, but the hereditary bases of organisms as wholes having this or that peculiarity. The bearing of the mosaic and organismal standpoints on various questions of evolutionary theory can be brought out only in the fuller paper of which this is a brief abstract.

Adaptation as a Process: Harry Beal Torrey, Reed College, Portland.

Some Genetic Studies of Several Geographical Races of California Deer Mice (projection of autochromes, with demonstrations and illustrations): F. B. Sumner, Scripps Institute for Biological Research, La Jolla, California.

Mice of the species *Peromyscus maniculatus* were collected in four regions of California, ranging climatically from the Mojave Desert to the humid northwest coast (Eureka). Fourteen characters of these mice have been measured, and the results subjected to statistical analysis. In general, the Eureka form (*rubidus*) differs more widely from the other three races than these do from one another, and hybridization has not thus far succeeded with it. *Rubidus* exceeds the others conspicuously in length of tail and foot, and to some extent in skull length and cranial capacity, comparison being made between animals of equal body length. This subspecies is also the darkest of the series. The increase in pigmentation, correlatively with increase in humidity, is a well-known principle to which these mice conform, but the increase in the length of the appendages toward the north (shown in *rubidus* and still more evident in Alaskan races) stands in contradiction to another well-known generalization, and is hard to reconcile with experimental evidence.

The subspecies *gambeli* from Berkeley or La

Jolla differs characteristically from the desert form (*sonoriensis*), but these differences relate almost wholly to pigmentation, that of the former being of a deeper shade and more extensive in distribution. Hybridization between these two races has proved easy, but I am not yet prepared to report upon the results.

The desert race has been transferred to the humid atmosphere of Berkeley and reared successfully. Neither the parent animals, nor an F_1 nor an F_2 generation has shown, however, any perceptible approach to the Berkeley type of coloration.

Some interesting modifications have resulted from captivity. Mice of the subspecies *gambeli* and *sonoriensis*, which have been reared from birth in confinement, have been found to differ from wild ones in having a distinctly shorter tail, foot, innominate bone and femur. No significant difference has been found in cranial capacity.

These experiments are being continued at the Scripps Institute, La Jolla.

Fossil Insects and Evolution: T. D. A. Cockerell, University of Colorado, Boulder, Colorado.

The U. S. National Museum possesses a very interesting series of English fossil insects, which originally formed part of the Brodie collection, but came into the possession of Lacoe, and finally reached the museum with the Lacoe collection. In the course of working over these specimens, occasion was taken to review the fossil insects of the British Islands, and incidentally to consider the mesozoic insects of other countries. Since this work was done, it has been ascertained that the British Museum possesses very much larger collections from the same source, which it is hoped to describe during the coming fall and winter. Mesozoic insects are of special interest because it was during this epoch that most of the modern families were established. The rise of the higher flowering plants was necessarily contemporaneous with a great development of insect life, and all the main outlines of this development were certainly completed before the beginning of the Tertiary. Unfortunately our knowledge of Mesozoic insects is extremely defective, but we know enough to reach some interesting conclusions. The English Lias contained great numbers of Coleoptera, and not only were several of the modern families apparently well established, but some of the species showed a well-defined elytral pattern of longitudinal dark stripes or bands, quite like the pattern seen in various living beetles, and varying in the same manner. Thus the outlines of elytral ornamentation, which might be imagined to be recent and unimportant, are actually of enormous antiquity, having been laid down before there were any Lepidoptera, so far as we know, and even prior to the appearance of Hymenoptera.

Great advances have been made in recent years in our knowledge of Tertiary insects, with the result of showing that on the whole progressive evolution has been extremely slow, most of the new species and even genera coming into existence by a shuffling, as it were, of old characters. Wheeler's researches on the ants of the Baltic amber have shown that in the Oligocene the Formicoidea were almost or quite as far advanced as they are to-day. A comparison of the Miocene Bombycid flies with those of to-day shows that at least in certain features, the fossils are not rarely more specialized than their modern representatives. The Garnet Bay Oligocene, a deposit in the Isle of Wight, is full of beautifully preserved insects, and when these have all been worked over we shall know a great deal about the English insect-faunas of that period. The work so far done confirms the general opinion that evolution has been very slow since that period, say within the last two million years. Where genera are strikingly different from those now living, they have simply become extinct. All this is of course very different from the condition among the mammalia. We are bound to conclude that the rate of evolution is extremely different in different groups of animals. The insects are fairly comparable with the Mollusca in this matter, but with this great difference, that the number of species of insects is enormously greater, and the adaptations are much more numerous and more diverse. The great stability of the main features of insect organization is therefore more remarkable. On the other hand, we find in the rocks many evidences of insect migrations, or of the former existence of families and genera where they are now extinct; so that we are cautioned against assuming too much from the present distribution of groups of insects. Insects are in general mobile creatures, and, given vast periods, may readily travel over the greater part of the habitable world. They are, on the other hand, commonly dependent on particular sets of conditions, and thus they are likely to be locally exterminated, the general result being a shifting of insect populations in the course of time, obscuring the original centers of distribution.

H. V. Neal,
Secretary

(*To be continued*)

SCIENCE

FRIDAY, NOVEMBER 5, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

SCIENCE AND LIBERAL EDUCATION[1]

SEVERAL years ago a discussion was carried on in one of the London newspapers on that interminable but always interesting question as to what is the best definition of a gentleman. Various answers were suggested by different contributors. Some were in the form of citations from our noblest literature—one, as I recall, was given in the words of St. Paul, another was taken from Shakespeare, a third from Emerson. The one generally acknowledged to be the most effective was, however, phrased in the picturesque vernacular of modern sport. A gentleman, so this answer ran, *is a man who plays the game.*

As this lingers in the memory it brings a growing sense of broader implications. The definition, evidently, only gives a new turn to the old thought that human life is like a great game that man plays with the world. We recall the striking words in which an illustrious master of modern science once brought this thought to bear upon the problem of education:

> The life, the fortune and the happiness of every one of us depend on our knowing something of the rules of a game infinitely more complicated and difficult than chess. It is a game which has been played for untold ages, each man and woman of us being one of the two players in a game of his or her own. The chess-board is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of nature. The player on the other side is hidden from us. We know that his play is always fair, just and patient. But also we know, to our cost, that he never overlooks a mistake or makes the smallest allowance for ignorance. To the man who plays

[1] An academic address given at the opening of Columbia University, September 29, 1915.

> well the highest stakes are paid, with that sort of overflowing generosity with which the strong delight in strength. And one who plays ill is checkmated—without haste, but without remorse. My metaphor will remind you of the famous picture in which a great painter has depicted Satan playing at chess with man for his soul. Substitute for the mocking fiend in that picture a calm, strong angel who is playing for love, as we say, and would rather lose than win, and I should accept it as an image of human life. . . .
>
> Well, what I mean by education is learning the rules of this mighty game. In other words, education is the instruction of the intellect in the laws of nature, under which name I include not merely things and their forces but men and their ways, and the fashioning of the affections and the will into an earnest and loving desire to move in harmony with their laws.

And a little farther on it is added that a liberal education should teach us to love all beauty, whether of nature or of art, to hate all vileness, and to respect others as ourselves.

Huxley here formulates his view of education in words that breathe the very essence and spirit of scientific inquiry. The end of education, obviously, is not the mere acquisition of knowledge; it is the attainment of a point of view. And the value of science in this respect, as I think, depends mainly upon the attitude of the scientific investigator towards the study of nature. For he, too, is like a player in a great game. He is quite aware that he can never bring it to a conclusion or sound all of its depths. Nevertheless, he throws himself into it without hesitation, certain of its inexhaustible interest and of possibilities of achievement that are past all reckoning.

I will say but a passing word concerning the work of our professional and technical schools of science. More and more in the future the practical efficiency of our civilization will depend upon that work—in medicine and sanitary science, in agriculture and forestry, in the many branches of engineering—in all those practical disciplines that we speak of as the applied sciences. But civilization does not live by practical efficiency alone, neither is education merely a matter of vocational training. Something larger is here involved. What is the greatest service of science to our intellectual and spiritual life? And this, I take it, is only another way of asking: What is the value of science in general or liberal education?

There are certain obvious aspects of the question that will detain us for a moment only. Science should teach us to keep an open mind; to look facts straight in the face. It should help to deliver us from the deadly vice of thinking we know things of which we are really ignorant. It should lead us to place a higher valuation on observation and experiment than on authority and precedent. We should, of course, acquire some definite information concerning the material world; we should become aware of the fundamental order that is discoverable among natural phenomena; we should gain an intelligent view of man's place in nature. The biologist is apt, perhaps too apt, to emphasize the bearing of his work on problems of human life—psychological, social, political, ethical. No one supposes that all the intricacies of the social organism are at present within the reach of biological searchlights; far from it. Nevertheless, we are ourselves objects in nature and a product of natural processes. No man, I venture to think, can be called liberally educated who has been left indifferent to the issues that are here involved.

But these things, too, let us pass by; they are plain to demonstration. I ask attention to something that is, perhaps, less obvious but to my way of thinking is more important still. The main service of science to our intellectual life is to help preserve us from a certain disorder of the

imagination which I will permit myself to speak of as the malady of Peter Bell. I make no attempt to disguise the fact that Peter Bell and his celebrated primrose have begun to show the ravages of time. Even so, I suspect that science will not with impunity lay her desecrating hand upon Wordsworth's parable. And yet that perennial primrose by a river's brim, which through every changeful year

> A yellow primrose was to him
> And it was nothing more—

that weather-beaten botanical specimen, I say, symbolizes a kind of mental myopia with which the man of science feels himself to be as much concerned as the poet. Science has a very definite part to play in the treatment of this insidious ailment. It should adjust our vision to the larger meanings of things in the material world. And by this I mean to say *that science should develop—and it should discipline—the constructive imagination.*

This thought, I must admit, is very far from novel; to some, nevertheless, it may seem to be a rather quixotic notion. Let me then briefly set forth some of the grounds that lead me to adopt it. I might cite here Tyndall's historic address on the scientific use of the imagination—one with which every student of science should be familar. But lest I be accused of calling upon a prejudiced witness, I will turn to the dry light of legal authority, recalling words that were written long ago by Sir Frederick Pollock:

> It is an open secret to the few, but a mystery and a stumbling block to the many, that Science and Poetry are own sisters; insomuch that in those branches of scientific inquiry which are most abstract, most formal, and most remote from the grasp of the ordinary sensible imagination, a higher power of imagination akin to the creative insight of the poet is most needed and most fruitful of lasting work.

This was an eminently sound and upright judgment, yet the mystery seems not wholly to have been dispelled. Even now we not infrequently are asked: Is not science a negation of all that is poetic or imaginative? Is it not concerned with hard facts, with exact weights and measures, with sharply defined and rigid concepts, with the iron rule of "blind force" and "inexorable law" in nature? Well, this view of science is known esoterically, in the seclusion of the laboratory, as the Great Myth. We can make some use of it, to be sure, as a kind of polite fiction with which to introduce the neophyte to the methods of science. We glibly insist that the student must above all things learn to observe, measure and weigh with "irreproachable accuracy." With this demand he struggles valiantly but in vain; meanwhile, however, the fundamental truth begins to dawn upon him that nobody is able with perfect accuracy to observe, measure or weigh anything. We are always in error, more or less. Science—and here I mean the sciences of observation and experiment—has not the smallest hope of attaining to absolute precision. She is quite content to determine the probable limits of error!

The fundamental concepts of science are in no better case than her weights and measures. They have no finality. They are but a means of advancing knowledge; they move as science moves. But yesterday we were told that atoms are infinitesimal, indivisible, ultimate. To-day we are holding our breath as we watch the physicist soaring upon the wings of imagination inside the atom in pursuit of still more infinitesimal, still more indivisible, still more ultimate electrons which, like the stars of heaven, are rushing through the tremendous solitudes of intra-atomic space! To-morrow, no doubt, the scene of these daring flights will be shifted to the nebulous and illimitable regions that lie still unex-

plored within the electron. What would the illustrious Dalton think of all this could he contemplate to-day the fate of his epoch-making theory after a century of scientific progress? We may imagine him saying to himself: "Well, Well! the concept of the atom seems to have made some progress since my time; evidently it still is moving onwards. And yet, the flourishing state of latter-day physics and chemistry gives me an impression that the atomic theory, with all its faults, has played a certain useful part in the advancement of knowledge."

Surely then, it may be said, we can make a final stand upon the laws of nature. Are not these immutable and eternal? Do they not govern the world as overruling necessities? Science and philosophy alike reply: Who knows? The laws of nature are known to us only as observed uniformities or harmonies of action. We can not affirm with certainty that any one of them—not the law of the conservation of energy, not even the law of gravitation—is fixed or universal. No particular law of nature—and here I employ the words of a great master of mathematical physics—will ever be more than approximate and probable, nor can we state it completely. But this, says some one, is a confession of the fundamental bankruptcy of science! No; our cynical friend goes too fast; his remark betrays a failure to comprehend either the aims of modern science or the nature of scientific progress. We have no notion that our plummets will so easily touch the bottom of nature; we do not hope to divine the final essence of things. And were it otherwise, were it possible for our knowledge of nature to be frozen, once for all, into a hard, mechanical and completed system, the most potent spell of science would be broken. A deep-seated instinct of our human nature here asserts itself; one that has found expression in the philosophy and poetry of every age. It is a saying of Confucius that they who know the truth are not equal to those who love it. Which one of us, were we forced to choose, would not in the end make the famous choice of Lessing:

> If God held in his right hand all truth, and in his left nothing but the ever-ardent desire for truth, even with the condition that I should err forever, and bade me choose, I would bow down to his left hand, saying, "Father, give me this; pure truth can be but for Thee alone."

Such a choice, however, is not very likely to fall to our lot; nor does the poet here suggest the actual attitude of science. Malbranche is nearer to it in that delightful remark that if he held truth captive in his hand he would open his hand and let it fly, in order that he might pursue and capture it again. Here we sense the spirit of the sportsman. With somewhat of the same spirit, beyond a doubt, does the discoverer play his small part in the mighty game of science.

And this brings us to the vital point. Not merely in a spirit of sportsmanship does science play her game; she also strives to realize an ideal, one that is very plain and simple. And this ideal is, in a single word, *progress*. Not to solve the ultimate riddles of the universe, if such there be, not to attain to absolute truth, but to advance knowledge—such is the aim of science. When once we have felt the full force of this, all is clear. Then we see that although the laws of nature can be formulated in only a tentative and provisional way, they are not for this reason less valuable to us; they are more so. Then we grasp Huxley's full meaning when he calls these laws the rules of the game we play. We can not with certainty ascribe to them any quality of necessary or inflexible truth. Our knowledge of nature is of inestimable value to us; but it is nowhere absolute or final. The profound

significance of what we call natural laws lies in the fact that they tersely sum up our experience of the world at any given moment; and, above all, they endow us with a gift of prophecy that leads us on to new advances. Just here we are in sight of what is most vital, characteristic and hopeful in the spirit of modern science; and here, too, the all-important rôle of the scientific imagination first begins really to impress us.

Our assured knowledge of nature is gained little by little, through the slow and cautious processes of observation, experiment and reason; but far different from these is the motive power of science. In every field the great discoverers have been seers, men of imaginative vision, carried onwards by a swift intuition that runs far in advance of solid fact or rigorous logic and ranges freely to and fro in undiscovered realms beyond them. And this is a true creative process, one that is singularly like what we call the inspiration of the painter or the poet. It often thrills us in the same way. Such a work of the imagination was Michael Faraday's wonderful anticipation of the electro-magnetic theory of light. Such was Charles Darwin's conception of natural selection which, as he himself has related, suddenly flashed upon his mind as he was reading the famous book of Malthus. Such, again, were the dreams that led Louis Pasteur and his followers, step by step, from the phenomena of fermentation and putrefaction to that most beneficent and practical achievement of our civilization—the germ theory of disease. At every point the material world overflows with half-revealed meanings about which science is forever weaving her imaginative fabrics; and at their best these have all the freedom, boldness and beauty of true works of art. One conspicuous trait, indeed, distinguishes the man of science—his incorrigible, almost automatic insistence upon verification. For no one better knows that the children of his imagination will live only in so far as they take on the living flesh and blood of reality in the appeal to nature. Not many of them survive the ordeal; yet they are the pioneers of progress, and the real conquerors of the world. Our own alma mater has placed above the portal of one of her great halls of science the words: "*Speak to the earth and it shall teach thee.*" Beside them we might fittingly inscribe that other Scriptural admonition: *Prove all things; hold fast that which is good.*

I say once more, then, that the development and discipline of the imagination is the best gift of science to our intellectual life, and hence to liberal education. Permit me also to suggest that there is no royal road, no pedagogical short-cut, that will lead us to it. Lectures and text-books on science are, I suppose, a necessary part of the apparatus of educational nutrition. Not by them, however, but by the actual phenomena of nature is the scientific imagination first awakened to its real life. Our laboratories of science have their shortcomings; in them, nevertheless, such as they are, the fruitful and abiding lessons of science are learned. It must not be imagined that the student has no other occupation than to disport himself at ease in that legendary realm of popular fancy known as the "fairyland of science." The prosaic but wholesome truth is that most of us are kept too busy digging out facts at lower levels to have much opportunity to breathe the atmosphere of the upper altitudes. But if the learner can not be taken up straightway to the highest mountain peaks, he may at least be enabled now and then to catch glimpses of them from the quarries in the foot-hills where most of us are toiling. And such moments of larger

vision repay with overflowing measure all the labor they have cost, for it is then that the miracle is wrought and the eyes of Peter Bell are opened.

Permit me one more word. Science lays her spell upon us because she lives and moves. It ought to be clear that the advancement of knowledge is not less vital to the educational interests of the university than are its conservation and dissemination. Are we quite sure of ourselves in this regard? We have heard of late an intimation that the universities have not been so much leaders of progress as "depositories of stationary thought." Well, depositories of stationary thought the universities indubitably have been, like the monasteries that they succeeded as centers of learning; and they have thus served as the guardians of a treasure that is beyond all price. But this is only half the truth; for it has long been one of our most cherished ideals that universities should also be the natural homes of original discovery and productive scholarship. The real universities—and I believe that our own is one of them—have demonstrated by their example that the atmosphere which these things create make teaching live and move. But even as we are insisting upon this we find ourselves wondering how our ideal is likely to fare hereafter in the continual expansion of modern universities and the multiplicity of new demands upon their teaching resources. Our pedagogical and executive machinery is admirably organized. It has developed a high degree of efficiency. Will it be efficient enough in the future to maintain an atmosphere in which scientific research and creative scholarship may freely breathe? It is easier to ask hard questions than to answer them. This one, nevertheless, we shall not escape; for the day is coming when the leadership of the universities in intellectual progress will depend on the reply that we and those after us shall make; and not our words, but our deeds will speak for us.

Edmund B. Wilson
Columbia University

PLAIN WRITING[1]

Two years ago I spoke to the American Mining Congress on the subject "Plain Talk"—both preaching the use of direct statement and trying to practise what I preached. Of late my thoughts have turned more and more to the need of the use of popular language in stating technical results; hence this afternoon I venture to discuss plain writing from the standpoint of a government scientist. For twenty-odd years my association with scientists has been fairly intimate, and though I may not qualify in plain writing myself, I can claim large acquaintance with both the written and the printed page whose meaning is far from plain.

At its best, science is simple; for science is not much more than arranging facts so as to set forth the truth. Scientific thought is exact and direct, and scientific writing must therefore be accurate and to the point. The scientist should think directly and with the precision of one of the instruments of his trade, and above all his language must present that thought exactly.

In scientific writing this need of exact statement has led to the use of special terms, words that keep their razor-edge because used only for hair-splitting distinctions. In a certain degree this adoption of words not commonly used is unavoidable and therefore defensible. Yet the practise is carried to an extreme and far too often the result is a highly specialized language so distantly related to our mother tongue that as a preliminary qualification the writer has to pass a civil-service examination and the reader usually finds himself "shut out" and facing a "no admittance" sign unless he happens to possess the degree of Doctor of

[1] Meeting of American Mining Congress, San Francisco, September 18, 1915.

Philosophy in that particular branch of science.

Mind you, it would be folly to throw away these tools so well fitted for special purposes; yet it is no more the part of wisdom to put them to every-day uses. The task for the scientist is to decide when to use his technical terms and when to talk United States. Of course, any writer's first duty is to be intelligible. Choice of language thus resolves itself largely into an understanding of the audience. If a scientific investigator desires to announce his discovery to his fellow workers, he does well to use those exact terms that carry the same shade of meaning the world over and indeed may have the same form in several languages; if, on the other hand, his results have immediate value for the mine operator or the prospector, the geologist does not and can not accomplish his purpose unless he writes in plain language, using words possibly less exact but surely more understandable.

It may be that I have stated the case too simply, so that this matter of plain writing may seem altogether easy, yet making out the prescription is always much easier than effecting the cure. Indeed, I suspect the difficulty is largely an internal trouble with the author, so deep-seated that my simple remedy of fitting the language to the reader does not reach it.

Sir Clifford Allbutt in his "Notes on the Composition of Scientific Papers" lays down the plain rule: "Take pains, therefore, with yourself first, then with your reader." His idea that clear thinking must be the first step to plain writing of course deserves our endorsement, based upon experience. How common is the sad discovery that a piece of obscure writing is simply the product of roundabout reasoning or twisted thinking. Printer's ink, in whatever amount used, unfortunately possesses no magic properties as a reagent for clarifying muddy thoughts. Yet no doubt it sometimes happens that some of us try to cover up with long words our uncertainty in thinking. So in preaching reform in scientific publications, those of us who are doing the work must realize that plain thinking comes first. There's the rub!

It is therefore not a coincidence that some of the deepest thinkers in geological science have also possessed a literary style conspicuous for clarity of expression. On the other hand, some authors whose English needs the most editing are equally careless in the quotation of facts determined by others and indeed in the statement of their own observations. I mention this simply to show that I am strong in my belief that plain writing is not something beneath the plane of endeavor of the scientific investigator—indeed, it is something so hard to attain that the most of us need to aim high, to raise our standards of scientific thinking. The use of common words is worthy of any writer if his purpose is to transmit thought.

The discussion of plain writing at this time is not academic, because my real purpose is to take this opportunity to announce to you the policy of the United States Geological Survey on this subject. Our explorations, surveys and investigations are in the public interest only as results are made public. This policy is as old as the Geological Survey itself, but several things have given a special impetus to the development of this policy. Beginning in August a year ago, a large volume of inquiries from producer and consumer of minerals came pouring into our office, and as never before the Geological Survey became a kind of "central" to the mineral industry. This opportunity for a larger service to the public not only resulted in gratifying relations with a large number of correspondents, but the rendering of such service has proved instructive to the public servants charged with the duty. Many of us on the Survey staff have acquired a keener realization of the need not only of giving the public the facts, but also of making those facts intelligible and useful to the citizen who may lack professional training in geology or engineering.

Another line of this larger service has been the issue of four guidebooks to this great western country, in which the purpose has been to inform the traveler concerning the resources of this part of our country as well as to unfold to him in attractive form its fascinating geology. The effort to meet the public need of

authoritative information of this type seemingly has met with success, and other guidebooks in this series will follow in other years. More than that, however, the reflex influence of this innovation is already felt, and the evident appreciation by the general public of this type of popular description is encouraging the Survey writers. The educational responsibility of this federal service is being more fully realized, and we intend to give much more attention both to the simplification of the language of the professional publications and to the issue of reports that shall be popularly descriptive and instructive without loss of exactness. Even if plain language is used our reports should be no less efficient vehicles for professional discussion or for the announcement of geologic discoveries.

For thirty-six years the United States Geological Survey has reached an ever widening circle of readers, and even in the early years of the Survey's life King and Emmons and Gilbert gave to the West the results of their work in strong and forceful English. Yet with the growth of the organization and the development of the science the tendency toward highly specialized writing has been too marked and the present plea for plain writing has become necessary. The government scientist has at least two obligations: first, that of making his investigations more and more exact in method and direct in result; second, that of making his product, the written report, such as to meet the needs of not only his professional associates but also the general public. It is our ambition that the reports of the United States Geological Survey shall be written in the language of the people.

GEORGE OTIS SMITH
U. S. GEOLOGICAL SURVEY

SOIL FERTILITY

As long as a soil continues to produce moderate crops, the question of its fertility arouses no concern, but when the yield falls below normal the reason for this decrease is immediately sought. Until a short time ago it was believed that this difficulty admitted of an easy solution, but when the farmer saw his crops decreasing and sought the cause, the type of answer which he received depended on whether he consulted a soil physicist, a soil chemist, or a soil bacteriologist. In any case it was generally conceded that the supply of "plant food" had been exhausted and the only question remaining was how to replenish it.

The soil physicist saw in this undesirable condition, from his standpoint, a violation of the maintenance of one of the following requirements for the soil under examination. First, the proper temperature had not been established in the soil to admit of the rapid growth of crops; second, the proper ventilation of the soil had been interfered with, either by a change in the porosity of the soil due to physical or chemical changes, or to the deposition and retention of the by-products of the crops; or third, the plant did not receive sufficient moisture and this was due to the nonoperation of one of the following agencies, osmosis, surface-tension or transpiration. The importance of this third point is very apparent when we remember that all plant food taken from the soil must be in solution.

The following quotation from Johnson's "Agricultural Chemistry" illustrates the standpoint of the chemist of a few years ago in regard to soil problems.

> The art of culture is almost entirely a chemical art, since nearly all its processes are to be explained only on chemical principles. If you add lime or gypsum to your land, you introduce new chemical agents. If you irrigate your meadows, you must demand a reason from the chemist for the abundant growth of grass which follows.

The extension of such ideas as are contained in the above quotations led to the belief that there is a certain definite relation between the productiveness of the soil and its content of nitrogen, potash, phosphoric acid or other chemical constituent, and many persons believe at the present time that from a chemical analysis of a soil the analyst can tell just the kind and amount of fertilizer to be added in order to increase its productiveness.

With the introduction of more exact methods in bacteriology and the perfecting of bacteriological technique, all of which has taken place

in the last half century, the relation of bacteria to soil cultivation has been carefully studied. There are myriads of bacteria in the soil and from the standpoint of the agriculturalist, they naturally fall into two classes: Those concerned in increasing the fertility of the soil, and those which deplete the soil of the necessary constituents to sustain plant life. Two groups of bacteria (*Clostridium* and *Azotobacter*) have the ability of taking nitrogen directly from the air and incorporating it into their own protoplasm, and it is believed that these organisms are responsible to a large extent for keeping the nitrogen content of a soil nearly constant, as they replace that lost from the soil by the removal of crops, dentrification (which will be considered later) and seepage. Another method by which the nitrogen content of a soil is increased is that of a symbiotic relationship between certain bacteria and plants; *Ps. radicicola* has the ability of penetrating the roots of the legumes and forming nodules thereon. Under this special condition, the bacteria above mentioned are able to "fix" atmospheric nitrogen. This element is rarely, if at all, available to plants in the form of ammonia, but must be built into nitrates first. Here other types of bacteria (nitrifying organisms) take the "fixed" nitrogen and build it up to nitrites and nitrates.

It is upon these facts that the excellent results of crop "rotation" depend and this is responsible for the success in intensive farming. In the "rotation" of crops the farmer sows the land between "money crops" with one of the legumes (peas, beans and especially clover are used) and these plants are those above referred to as being capable of a symbiotic relationship with the nitrogen-fixing bacteria. When these legumes have grown up, they are ploughed under, thus returning much nitrogen, which has been accumulated during their growth to the soil, and replacing that lost by the removal of the "money crops." This process is known as "green manuring" and it is fast becoming the practise to spray the seeds of these legumes with pure cultures of nitrogen-fixing organisms, so that the proper bacteria may be present when the seeds are planted.

The question naturally arises that if nitrogen must be in the form of nitrates in order to be available to plant life, why is it that we often add materials as fertilizers which contain nitrogen in a much more complex form? Bacteriology again answers this query. These complex nitrogenous substances which we add as fertilizers are broken down by the saprogenic and saprophilic bacteria to the ammonia stage from which they are built up, through the agency of the nitrifying bacteria to the nitrite and finally nitrate form, and are now in a condition to be assimilated by plant life. Through the agency of other bacteria cellulose, starches and sugars are transformed to organic acids and carbonic acid, which attack otherwise insoluble minerals and get them into solution ready for absorption by the plant. Bacteria are also involved in the oxidation of hydrogen sulphide and iron compounds.

So far, we have discussed only those organisms which are beneficial to plant life, but there are others which are detrimental and these naturally fall into two classes; first, those bacteria which are pathogenic to plants, like those causing tobacco and cucumber wilt, potato rot, pear blight, etc., second, those bacteria which are indirectly harmful to plants because they rob the soil of the constituents necessary to support plant life. These latter fall in the group above referred to as denitrifying organisms and they have the ability to break down nitrates, either partially or wholly to the ammonia stage, thus robbing the plant of what was originally available nitrogen. This type of organism was much feared by the agriculturalist for some time after its discovery, but it is now known that it requires an entirely different environment from the nitrifying organisms and that it seldom occurs in a well-ventilated soil.

The single view of the soil physicist must appear untenable, for while plants need water, air and a proper temperature, these are not the only requirements to be met, for if it is desired to have a fertile soil to insure our crops, "plant food" must be present and also the

agencies whereby this food will be replaced when that which is now present is consumed. We must also recall that water, air and temperature greatly influence the bacterial content of the soil and they are probably more sensitive to changes in respect to these three requirements than are the plants themselves. As will be seen later, it is possible to meet all the demands of the physicist and yet have an unproductive soil.

The single standpoint of the chemist is also open to criticism, for, granting that the right amounts of the necessary elements are present in the soil and are in an available form at the time of examination, they will soon become exhausted unless replaced by bacterial activity. The amount and kind of material in the soil solution is one that has caused considerable discussion and for which we can set no arbitrary standards, knowing that this is intimately related to the composition of the soil, which is dependent upon the original nature of the rock of this place and the care of the land since it has been cultivated. Would it, remembering that different animals require different kinds and amounts of foods to repair their protoplasms, be quite correct to assume that all plants require exactly the same amounts of various substances to repair their equally diversified protoplasms?

While it may be claimed that the bacteriological content of a soil is a very delicate index of its fertility, we must not forget that the chemistry and physics of the soil are also important. It is true that from the type of bacteria present we can form a good idea of the fertility of the soil, but without the knowledge gained from a physical and chemical examination we have no means of knowing how long these conditions will persist.

The problem of soil fertility then is a composite one which needs for its solution a knowledge of the interrelated subjects physics, chemistry and bacteriology. With these points in view, it becomes a very simple matter to harmonize statements which on the surface seem conflicting. We now know that it is necessary to provide the proper laboratory (physical conditions) and the necessary raw material (chemicals, etc.) in order that the particular bacterial cell which we desire may do its work in increasing the fertility of the soil. In order to show the dependence of the bacterial cell on physical factors, we may cite the physicist's demand for a porous soil and remember at the same time that the organisms beneficial to plant life require oxygen in order to continue their reactions. Again the necessity for moisture is clear when we remember that bacteria can use only food that is in solution, and the question of a proper temperature is explained when we remember that at the optimum temperature of the bacteria in question, their reactions are greatly accelerated.

To discuss in detail the tenets of the chemist would require too much space here, but one simple illustration may suffice to show the close relationship between the chemical composition of a soil and its bacteriological content. The adding of chemicals to a soil affects the physical and bacteriological nature of the soil as well as the chemical content. When we remember that the activity of bacteria often produces acid end-products, which if not neutralized will inhibit their activity and finally cause their death, the reason for the addition of lime to a soil is easily understood.

If we provide all the conditions above outlined and the soil continues to be unfertile, we may be sure that we have not the proper bacteria present or else some enemy such as certain protozoa are present and are preying on those bacteria which make plant life possible upon the earth. As animals are in the last analysis dependent upon the plants for food, and as plants are dependent upon the nitrifying bacteria, we can easily see that no life could long exist upon the earth without the aid of these organisms.

J. E. RUSH

DEPARTMENT OF BIOLOGY,
CARNEGIE INSTITUTE OF TECHNOLOGY

THE THIRTEENTH NEW ENGLAND INTERCOLLEGIATE GEOLOGICAL EXCURSION

THE annual meeting of the Geologists and Geographers of the New England Colleges and Universities was held under the direction of

Professor Joseph Barrell, of Yale University, on Friday and Saturday, October 15–16.

The purpose of the excursion was to determine whether or not the so-called Cretaceous peneplain of southern New England was the work of subaerial or of marine erosion, and was conducted by the author of the latter theory.

In the preliminary lecture delivered in Peabody Museum, Yale University, Professor Barrell pointed out that the importance of peneplanation in continental interiors was not questioned nor the quantitative dominance of river erosion even on the eastern side of the Appalachians. From evidence based on a broad study of the country between Vermont and Virginia it was concluded that the so-called peneplain of southern New England was originally stair-like or terraced in its character, the terraces facing the sea and bearing the marks of having been developed by recurrent marine denudation. By projecting the base of the Potomac and later formations their relations were brought out with the marine terraces of Maryland. The oldest terrace is regarded as Upper Cretaceous. The Piedmont plateau is regarded as developed by alternations of marine and subaerial denudation during the Pliocene.

The party left New Haven Saturday at 8:00 o'clock for Waterbury, Conn., where automobiles awaited. The route traversed extended through Morris, Litchfield and Goshen to Torrington. Luncheon was eaten in Litchfield.

The four terraces recognized in this region by the leader, regarded as Pliocene in age, and pointed out to the party are:

Cornwall terrace, elevation 1,680–1,720,
Goshen terrace, elevation 1,340–1,380,
Litchfield terrace, elevation 1,100–1,140,
Prospect terrace, elevation 880–920.

Of these terraces the Prospect in the locality viewed was seen to have been much dissected by subaerial erosion while the Litchfield has a remarkably smooth surface. No line of cliffs separates these two terraces, the separation being determined largely from topographic maps by the rather rapid descent of the surface near the junction of the two terraces. Rather pronounced but much dissected scarps between the Litchfield and Goshen and between the Goshen and Cornwall terraces were pointed out.

It was suggested by members of the party that the terraces might have been caused either, (1) by monoclinal warping or, (2) by a difference in the hardness of the rock. It was pointed out by one of the physiographers, however, that mere difference in hardness of rock would hardly account for the succession of dissected levels which was observed. The leader regarded monoclinal warping as inapplicable when applied to the actual details as developed across the country.

In general, Professor Barrell holds that the highest or Cornwall terrace was first cut by the marine erosion of a region of slight relief. The region was then raised, perhaps 400 or 500 feet, the sea retreated, subaerial denudation etched out the land surface, then moderate submergence took place to a level about 340 feet below the Cornwall level and the second or Goshen terrace was planed. Another oscillation resulting in a final elevation of 240 feet more permitted the sea to cut the Litchfield terrace. The Prospect terrace was cut when the region was raised about 220 feet further and perhaps after a prolonged stage of subaerial denudation. Lower and younger levels were cut by the waves on the seaward slopes before the sea reached its present position with reference to the land, each phase being represented by subaerial denudation farther inland. The sediment which had been spread over the sea bottom as the land was cut away to form the terraces has been removed by the streams since the successive terraces were subjected to subaerial erosion.

Twelve colleges and universities were represented by the fifty-two persons who were on the excursion.

The beauty of the autumnal coloring and of the region traversed added pleasure to one of the most interesting and largely attended of these annual excursions.

H. F. CLELAND,
Secretary

THE WILLARD GIBBS PROFESSORSHIP OF RESEARCH IN PURE CHEMISTRY

In course of the academic year 1914–15, a new department was established on a permanent basis in the Mellon Institute of Industrial Research of the University of Pittsburgh, namely, a department of research in pure chemistry. The headship of this department is to be known as the Willard Gibbs Professorship of Research in Pure Chemistry, "to ever proclaim the ideal which the incumbents of the chair and the groups of research workers to be associated with them will be expected to follow." It constitutes a chair in the graduate school of the University of Pittsburgh as well as in the Mellon Institute.

Dr. Martin A. Rosanoff, who had built up and for years headed the graduate department of chemistry in Clark University, was formally inaugurated as the first permanent incumbent of this professorship, at exercises held in the Assembly Hall of the Mellon Institute on October 26. The exercises included addresses by Professors James McKeen Cattell and Marston Taylor Bogert, both of Columbia University, and by Dr. Rosanoff, followed by a reception and an inspection of the Mellon Institute.

Chancellor Samuel Black McCormick presided at the exercises. He explained the circumstances connected with the establishment of the chair and thanked the donors whose generosity had made possible the endowment, of which the income, amounting to $5,000 per annum, is to constitute the salary of the incumbent of the chair. He then introduced Dr. Cattell.

Dr. Cattell spoke on "The Support of Scientific Research in a Democracy."

His argument was that science with its applications had given us democratic institutions by so greatly increasing the productivity of labor and the length of life, that it had become possible to provide for education and equality of opportunity. But scientific research, unlike most services, can not be sold to individuals; it is for the benefit of all and must be paid for by all. Hitherto aristocratic institutions have been more favorable to scientific research than ours, but we are now beginning to equal the leading European nations in our contributions to the advancement of science. We must do much more in the future. Coal is mined in Pennsylvania to the value of some three hundred million dollars a year. In so far as natural resources are consumed, ten per cent. of the proceeds—thirty million dollars a year—might very properly be devoted to discovering new ways to obtain energy. The manufactures of the city of Pittsburgh and of Allegheny County are worth more than three hundred million dollars a year. These, like the proceeds of the mines, have been made possible by the applications of science. Ten per cent. of their value—another thirty million dollars a year—might to advantage be spent in this city for the further advancement of science under the auspices of the University of Pittsburgh. By the Bessemer steel process the world saves, according to the estimates of the late Abram S. Hewitt, each year two billion dollars; by the electro-magnet discovered by Faraday in the only research laboratory then existing, the world earns each year perhaps twice as much. Why should not these six billion dollars a year be set aside as a memorial to the scientific men and workers in technology who have provided the world with its vast wealth, to be used for the further increase of this wealth and for the welfare of all? We could afford to devote one tenth of all labor, one fourth of all wealth, to scientific work, and we should become each year a richer and a greater nation. We need a Mellon Institute for each science and in every city.

Following Dr. Cattell, Dr. Bogert, who was introduced by Dr. Raymond F. Bacon, director of the Mellon Institute, spoke on "The Especial Value of Research in Pure Chemistry."

After rapidly reviewing some of the more striking contributions which chemistry has made to civilization, he pointed out that it was research in pure science which laid the deep and abiding foundations upon which applied science has erected all the wonderful structure of modern industrial processes. The nineteenth century has been called the Age of Physics and Engineering, but the twentieth will surely be the Age of Chemistry.

Dr. Bogert referred to the great service

which the University of Pittsburgh and its Mellon Institute are now rendering the public, and congratulated them upon the establishing of the new chair of research in pure chemistry as one of the most effective ways of furthering research and a momentous step in the direction of building up a splendid new graduate school. He believed that a university's true greatness was not measured by the magnificence of its plant, the size or athletic prowess of its student body, but by excellence of its graduate school, and that the standard of the latter was determined by the amount and quality of its production of genuinely original work, and the character of its faculty. He said, further, that the extent of the assistance which a university secures from its surrounding community in the creation of such a fine graduate school as that of the University of Pittsburgh was often a good indication of the attitude of the university authorities themselves toward such work. In this respect he said that the University of Pittsburgh was, indeed, fortunate in having a chancellor and trustees who knew how to prize original scientific investigation at its real worth, and under whose fostering care and guidance it would have full opportunity to grow and flourish.

The designation of the new chair as the Willard Gibbs professorship of research in pure chemistry was peculiarly appropriate, and should prove a constant inspiration to all incumbents in their search for truth. Dr. Bogert also congratulated the chancellor and Director Bacon upon securing as the first occupant of the chair so distinguished a scientist as Dr. Rosanoff—chemist, physicist, mathematician and linguist—whose investigations, especially those on distillation and the catalysis of organic reactions, have already won for him an enviable international reputation. He then felicitated Dr. Rosanoff upon his appointment to a post of such conspicuous dignity and honor. In closing, the speaker called attention to the fact that it was the development of genius that was of greatest concern to the world, and that many of the investigations carried out by the Willard Gibbs professors would undoubtedly survive long after the beautiful buildings of the university had crumbled in decay.

The last of the addresses was a brief discourse on Willard Gibbs's life and work by Dr. Rosanoff. In the conclusion of his address, Dr. Rosanoff expressed the sentiment that a man whose intellectual achievement is as wonderful as that of Willard Gibbs need hardly be honored either by a monument in stone or bronze or even by so magnificent a memorial as a professorship of research endowed in perpetuity. The sense of attaching his illustrious name to the new chair is really the hitching of the wagon to a star. And Dr. Rosanoff solemnly pledged himself, ever guided by the light of that star, to humbly follow in the steps of the great American master of scientific research.

The Department of Research in Pure Chemistry of the Mellon Institute is to be conducted along the same lines as similar departments in the leading universities in this country and abroad. Graduates of colleges in good standing will be admitted to it as candidates for the master's and doctor's degrees, and it will be the principal duty of the head of the department to maintain in it the highest attainable academic standard. The industrial research fellows of the Mellon Institute and the members of the faculty of the school of chemistry of the University of Pittsburgh, as well as the members of the Federal Bureau of Mines and of Standards, are at liberty to attend all lectures, seminars, and other exercises conducted in the department. Further, the head of the new department promotes the industrial ends of the Mellon Institute by any scientific advice that he may be able to give in connection with the work of the industrial research fellows.[1]

The department of research in pure chemistry occupies a suite of rooms in the Mellon Institute building[2] and its members are at liberty to draw on the material facilities of the institute on the same terms as the members of

[1] On the object and work of the Mellon Institute, see *J. Ind. Eng. Chem.*, 7 (1915), 343.

[2] For a description of this building, see *J. Ind. Eng. Chem.*, 7 (1915), 333.

the industrial section. Those of the graduate students who are granted the title of fellow in pure chemistry are considered by the Mellon Institute as equal in rank and privileges with the industrial research fellows.

W. A. HAMOR[8]

FREDERIC WARD PUTNAM

THE following minute on the life and services of Professor Putnam was placed upon the records of the Faculty of Arts and Sciences of Harvard University at the meeting of October 26, 1915:

Frederic Ward Putnam, son of Ebenezer and Elizabeth Appleton Putnam, was born in Salem, Massachusetts, April 16, 1839. His ancestors on both sides were early immigrants from England, the first American ancestor being John Putnam, who settled in Salem in 1640. The father, grandfather and great-grandfather of Professor Putnam were all graduates of Harvard College, and the associations of his mother's family had been close with the institution from its beginning.

His early schooling was received in private schools and at home under his father's tuition. At an early age he showed great interest in natural history and had thoughts of devoting himself to scientific pursuits. Promised an appointment at West Point, however, he was preparing himself to adopt a military career, when Louis Agassiz met him at the Museum of the Essex Institute, and, recognizing in him a keen student, persuaded him to take up natural history as his life work. His preparation for the military profession was accordingly abandoned, and he devoted himself at once to the study of birds, being made curator of ornithology in the Essex Institute in 1856. In the following year he was made assistant to Professor Agassiz, and entering the Lawrence Scientific School received the degree of S.B. in 1862. For a number of years after this, he continued his work in the study of animal life, as curator of vertebrates at the Essex Institute, of Ichthyology at the Boston Society of Natural History, and as assistant in the museum of comparative zoology at Harvard University. During these years he had also some experience in museum administration, as he was entrusted with the charge of the Museum of the Essex Institute and of the Museum of the East Indian Marine Society in Salem, and later was made director of the museum of the Peabody Academy of Science in the same city. In 1873 he was chosen to fill the important position of permanent secretary of the American Association for the Advancement of Science, an office which he held for twenty-five years. Professor Putnam's connection with the association lasted through one of the most important periods in its life, and to his energy and administrative ability much of its success was due.

Although it was in the field of natural history that Professor Putnam for many years carried on most of his work, his interest in archeology was early aroused. While attending the meeting of the American Association at Montreal in 1857, he discovered on Mt. Royal a small kitchen-midden, and was thus among the very first in this country to recognize the presence of the remains of prehistoric man. In 1874 Dr. Jeffries Wyman, the first curator of the Peabody Museum of American Archeology and Ethnology, died and Professor Putnam was appointed to take the place. Thus began his connection with the institution of which he was the director for over forty years. In 1886, he was made Peabody professor of American archeology and ethnology, and served as such until 1909, when he joined the group of the emeriti. During the nearly half-century of his connection with the museum, he labored unceasingly to build up its collections, both by purchase and by explorations in the field. He was one of the earliest to realize the need of archeological and anthropological exploration, and to insist that careful field-notes and data are equally important with the specimens themselves. The great collections which he gathered and which place the museum in the forefront of the museums of this country, are a witness of his success.

With the appointment to the Peabody professorship, Harvard University became one of the first institutions in the country to offer instruction in the field of anthropology and American archeology. Although always more active in museum and field-work than in teaching, Professor Putnam strove constantly to develop the instruction in his chosen science, from the time when, before any courses were offered, he had several voluntary students working under his direction, to the very last days of his life, when nearly a score of specialized courses were offered by the division of which he had for so long been the head.

Striking as were the results of his work here at Harvard, his influence was literally nation wide, and he may justly be called one of the fathers of

[8] Assistant to the director of the Mellon Institute of Industrial Research.

anthropology in America, the others being Brinton, of Pennsylvania, and Powell, of Washington. In 1892, he was made chief of the department of anthropology at the World's Columbian Exposition at Chicago, and not only brought together what was probably the greatest archeological and anthropological exhibit ever gathered in this country up to that time, but collected by the aid of numerous collaborators a vast mass of data in regard to our native peoples which has not yet been fully worked up. The specimens so brought together for the Exposition became the nucleus of the present Field Museum of Natural History, which may thus be regarded as, in its origins, of his making. In 1894 Professor Putnam was made curator of anthropology in the American Museum of Natural History in New York City, and for nearly ten years he applied to its administration and to the building up of its collections the experience he had gained in Cambridge and Chicago. It was again largely through his efforts that the University of California established a department of anthropology in 1903, and he held the position of professor of anthropology and director of the anthropological museum in that institution until his retirement in 1909.

In his long life of scientific work, a great deal of Professor Putnam's attention was necessarily devoted to administrative and editorial duties, but he found time, nevertheless, for the writing of a large number of scientific papers, and the bibliography appended to the Anniversary volume presented to him in 1909 by his associates and students, contains something over four hundred titles. His membership in scientific societies, both at home and abroad, was extensive. In this country he was a member of the National Academy, the American Academy of Arts and Sciences, the American Philosophical Society, and a great many others; outside the United States he was an honorary or corresponding member of the anthropological societies of Great Britain, Paris, Stockholm, Berlin, Rome, Florence and Brussels, of the Royal Society of Edinburgh, and others of minor importance. In 1868 he received the degree of A.M. from Williams College; in 1894 the degree of S.D. from the University of Pennsylvania; and in 1896, the Cross of the Legion of Honor from the French government.

Professor Putnam was twice married: in 1864 to Adelaide Martha Edmands of Cambridge, by whom he had three children, two daughters and one son. After her death, fifteen years later, he married in 1882 Ester Orne Clarke, of Chicago, who, with his three children, survives him.

To his students and associates Professor Putnam endeared himself by his kindliness and sympathy. For every one he had a cordial greeting and a pleasant word. He was ready always to give unstintedly of his time, and so far as he was able, from his pocket, to any one who asked his aid. He had the gift of inspiring those with whom he came in contact with enthusiasm for research, and to few is it given to have so wide an influence. Until the very last years, the great majority of those in this country who were working in the anthropological field had been associated more or less closely with Professor Putnam, either as students or colleagues in the various institutions of which he had been a member. His loss, therefore, is widely felt, not only because he was an able administrator and the last of the three founders of anthropological study in this country, but also because he had won the affections of so many as a teacher and a friend.

SCIENTIFIC NOTES AND NEWS

PROFESSOR M. I. PUPIN, of Columbia University, will give a lecture on "The Problem of Aerial Transmission," at the approaching meeting of the National Academy of Sciences. The lecture will be given at the American Museum of Natural History, New York City, on the evening of November 15.

AT the recent meeting of the Clinical Congress of Surgeons of North America, at Boston, Dr. J. M. T. Finney, of the Johns Hopkins University, was elected president.

DR. RICHARD MILLS PEARCE, professor of research medicine in the University of Pennsylvania, received the degree of doctor of science from Lafayette College on October 20.

THE Geographical Society of Philadelphia presented on November 3 its Elisha Kent Kane medal to Professor Ellsworth Huntington, of Yale University. Dr. Huntington gave a lecture on "Climate, Weather and Daily Life."

ACCORDING to a cablegram to the daily press from Stockholm it has been decided to award the Nobel Prize in medicine for 1914 to Dr. Robert Barany, of the University of Vienna, for his work in the physiology and pathology of the ear.

THE College of Physicians of Philadelphia announces that the Alvarenga prize for 1915 has been awarded Dr. Joshua E. Sweet, Philadelphia, for his essay entitled "The Surgery of the Pancreas."

M. PAUL PAINLEVÉ, professor of mathematics in the University of Paris and professor of mechanics in the Paris Polytechnic School, has been made minister of education in the new French cabinet.

THE French minister of war has appointed a consulting committee of experts on military aeronautics which includes M. Appell, who occupies one of the chairs of mechanics at the Sorbonne; M. Deslandres, director of the Meudon Observatory, and M. Kling, director of the Municipal Observatory.

SURGEON W. MCCOY, now in charge of the leprosy investigations at the hospital at Molokai, Hawaii, has been appointed director of the hygienic laboratory of the U. S. Public Health Service, succeeding Dr. John F. Anderson, who recently resigned.

DR. SIGISMUND S. GOLDWATER retired this week from the post of health commissioner of New York City and is succeeded by Dr. Haven Emerson, deputy health commissioner.

MR. P. BARACCHI has resigned as state astronomer of Victoria, and it is said that no appropriation will be made by the government for the Victorian Observatory at Melbourne.

PROFESSOR JOHN FERGUSON has retired from the regius chair of chemistry in the University of Glasgow, to which he was appointed in 1874.

PROFESSOR POLLITZER, of Vienna, the distinguished otologist, has celebrated his eightieth birthday.

PROFESSOR ERNST NEUMANN, formerly director of the pathologic institute in Königsberg, and a well-known authority on diseases of the blood, celebrated the sixtieth anniversary of his doctorate on September 24.

D. J. GUZMAN has been appointed director of the Institute of Vegetal Pathology in Salvador, Central America, as organized under the ministry of agriculture of that government.

DR. J. S. CALDWELL, plant physiologist of the Alabama Experiment Station, has been appointed to a position as specialist in fruit by-products investigations at the Washington Experiment Station, State College of Washington, Pullman.

DR. J. N. ROSE, research associate of the Carnegie Institution of Washington, has returned from a five months' exploration trip along the east coast of South America, where he made extensive botanical collections, especially of cacti, ferns and mosses. His collection consists of herbarium, formalin and greenhouse material, supplemented by numerous photographs.

ANOTHER expedition to Japan and Korea has been undertaken by Associate Professor Frederick Starr, of the University of Chicago, who sailed from Tacoma by the *Mexico Maru* on October 7. His photographer and helper on the expedition will probably be Hambei Maebashi, of Tokyo. The expedition is planned to cover six months' time, Professor Starr expecting to return to the university in time for the opening of the spring quarter in April, 1916.

PROFESSOR HENRI T. HUS, of the botanical department of the University of Michigan, has been granted a three years' leave of absence from the university, beginning with the present college year, in order to enable him to accept a position with the United States Rubber Company in Sumatra. Professor Hus will take charge of experimental plant breeding work on the island.

THE expedition under Captain Vilkitski in the ice-breakers *Taimur* and *Vaigach*, which last year started from Vladivostok to renew the attempt to reach Europe by the Arctic Sea north of Asia, and which wintered in 100° E. longitude off the Taimur peninsula, reached Archangel during September, having thus for the first time accomplished the complete northeast passage in the reverse direction from that folowed by the *Vega*.

WE learn from *Nature* that the council of the Chemical Society, London, has arranged for three lectures to be delivered at the ordinary scientific meetings during the coming

session. The first of these lectures will be delivered on November 18, by Dr. E. J. Russell, who has chosen as his subject, "The Principles of Crop Production." The titles of the two later lectures to be delivered on February 3 and May 18, by Professor W. H. Bragg and Professor F. Gowland Hopkins, respectively, will be announced later.

THE annual commemoration of the benefactors of the Royal College of Physicians of London took place on October 18, when the Harveian Oration was delivered by Dr. Sidney Coupland. The usual dinner was not held.

A GRANITE boulder has been placed on the campus of Cornell University to serve as a memorial of the late Ralph Stockman Tarr, professor of geology and physical geography, 1892–1912. The stone stands almost under one of the windows of the lecture room in McGraw Hall where Professor Tarr met his classes for many years. A bronze memorial tablet will be set into the eastern side of the boulder. The tablet has been designed by Mr. H. S. Gutsell, of the college of architecture. It will bear a portrait bust in low relief and the inscription:

RALPH STOCKMAN TARR
1864–1912
Scientist—Writer—Teacher

This boulder, a relic of the ice age, symbolic of his research in glacial geology and of the enduring value of his work, is placed here as a memorial of their friend and adviser by his students.

NATHAN FREDERICK MERRILL, professor emeritus in the University of Vermont, died on October 26 at the age of sixty-six years. He was for thirty years professor of chemistry in the University of Vermont.

ANDREW FERRARI, a chemist known for research work in glass manufacture, died at Hartford, Conn., on October 26, aged seventy-six years.

ALICE GERTRUDE McCLOSKEY, A.B. (Cornell, '08), assistant professor of rural education in the college of agriculture, Cornell University, died on October 19.

DR. JOHN MEDLEY WOOD, director of the Natal Herbarium and formerly director of the Natal Botanic Garden, died on August 25, at the age of eighty-six years.

MAJOR A. J. N. TREMEARNE, an Australian by birth, known for his publications on the anthropology of the African races, was killed in Flanders on September 25.

PROFESSOR SCHMIDT-RIMPLER, formerly ordinary professor of ophthalmology, died at Halle, on September 23, aged seventy-seven years.

DR. TIEFENBACHER, emeritus professor of railway engineering in the Vienna School of Technology, has died at the age of seventy-two years.

ACCORDING to *Nature* the third annual meeting of the Indian Science Congress will be held in Allahabad from January 13–15, 1916, when Sir Sidney Burrard, F.R.S., will be president. The chief sections will be physics, chemistry, zoology, botany, agriculture and ethnology, and the presidents of the respective sections Dr. Simpson, of the Meteorological Department; Dr. Sudborough, of the Research Institute, Bangalore; Dr. Woodland, of Allahabad; Dr. Howard, of Pusa; Mr. Coventry, of Pusa; and Mr. Burn. It is hoped that the local committee will persuade Dr. Bose to give a public lecture on his own researches. The local secretaries for this year are Dr. Hill, of Muir College, and Mr. P. S. Macmahon, of the Canning College, Lucknow, to the latter of whom all communications should be addressed. The congress is under the general control of the Asiatic Society of Bengal.

LEADING Philadelphia physicians are working out a plan to make Philadelphia a great center of advanced research and study in medicine. More than one hundred physicians have joined the Cooperative Association for Post-graduate Teaching of Medicine, which is the temporary organization to bring about this advance in Philadelphia's medical life. Dr. David Reisman, 1715 Spruce Street, is chairman, and Dr. George P. Mueller, 1729 Pine Street, is temporary secretary. Dr. J. M. Anders is chairman of the executive committee, on which are the following physicians: W. M. L. Coplin, F. X. Dercum, P. B. Hawke, Edward Martin, Charles K. Mills, George P. Muller, R. M.

Pearce, David Reisman, W. L. Rodman and George E. de Schweinitz. The subcommittee on roster includes Ward Brinton, R. Max Goepp, F. C. Hammond, John A. Kolmer, R. V. Patterson, C. M. Purnell, W. J. Taylor, T. H. Weisenburg, A. D. Whiting and Samuel Woody. A central bureau with a permanent secretary is to be established. The preliminary work to be done includes tabulating the lecture courses, laboratory hours, hospital and dispensary hours and getting the cooperation of all medical schools and hospitals in the city so their doors will be open to the post-graduate student.

AT the annual meeting of the National Association of Audubon Societies held recently in the American Museum of Natural History there was an exhibition of motion pictures by Mr. Herbert K. Job, who was sent by the association on a tour of inspection of the bird reservations in Florida and Louisiana.

IN a report of the clay-working industry of the United States in 1914 by Jefferson Middleton, issued by the United States Geological Survey, the value of the clay products of this country in 1914 are given as $164,986,983—brick and tile $129,588,822 and pottery $35,398,161. This was a considerable decrease compared with 1913, but as compared with the value for the last twenty years it shows a great growth in the industries. Compared with 1908 there was an increase of $31,789,221. In only four years—1909, 1910, 1912 and 1913—has the total value of clay products exceeded that of 1914. Considered by the average for five-year periods, which is perhaps the fairest comparison, as unusual conditions may occur in a single year, the average annual value of the clay products of the United States was: 1895–1899, $72,233,056; 1900–1904, $118,135,826; 1905–1909, $153,838,231, and 1910–1914, $170,287,909. It will be seen that the value of the clay products of the country has considerably more than doubled in the last twenty years. With the revival of business, which is clearly indicated, the great clay-working industries, with the inherent superiority of their products for many uses, are bound to come into their own, the halt of 1914 being but a temporary setback which will be more than overcome in the near future. Clay products are made in every state. Of the territories, Alaska and Hawaii reported none. The value of clay products ranged in 1914 from $5,974 in Porto Rico to $37,166,768 in Ohio. Ohio reported over one fifth of the value of clay products in 1914 and has been the leading state since figures on this subject were first compiled by the Geological Survey in 1894. It is likely to maintain this position, as its output has always greatly exceeded that of the second state, Pennsylvania, and in 1914 this excess was $15,319,772, or over 70 per cent. Pennsylvania's output in 1914 was valued at $21,846,996, or over one eighth of the total for the United States. New Jersey ranked third in 1914, with products valued at $16,484,652. Illinois was fourth, with products valued at $13,318,953, and New York was fifth, with products valued at $9,078,933. Indiana was sixth; Iowa was seventh, exchanging places with Missouri, which was eighth; West Virginia was ninth, exchanging places with California, which was tenth. The first ten states reported wares valued at $128,253,688, or 72.74 per cent. of the total. The first five states reported wares valued at $97,896,302, or nearly 60 per cent. of the total.

UNIVERSITY AND EDUCATIONAL NEWS

MR. JAMES J. HILL has presented $125,000 to Harvard University to be added to the principal of the professorship in the Harvard graduate school of business administration, which bears his name. The James J. Hill professorship of transportation was founded by a gift of $125,000, announced last commencement day, the donors including John Pierpont Morgan, Thomas W. Lamont, Robert Bacon and Howard Elliott.

THE General Education Board announces that $100,000 has been given to Carlton College, Northfield, Minn., toward a fund of $400,000; $50,000 to Hobart College, Geneva, N. Y., toward a fund of $200,000; $200,000 to Lafayette College, Easton, Pa., toward a fund of $1,000,000, and $25,000 to Kalamazoo Col-

lege, Kalamazoo, Mich., toward a fund of $100,000.

The trustees of the Joseph Bonnheim Memorial Fund, founded in 1897 by Albert Bonnheim and Fannie Bonnheim, of Sacramento, in memory of their son, have conveyed the entire property of the trust, now valued at approximately $100,000, to the University of California. The income of the endowment will be devoted to scholarships in the University of California for young men and young women.

Construction is about to begin on a laboratory building, to cost $100,000, to be erected by the University of California on the new 465-acre site just purchased by the University of California, at a cost of $55,000, for its citrus experiment station and graduate school of tropical agriculture at Riverside. The director of this work of agricultural research at Riverside is Dr. Herbert J. Webber, former professor of plant breeding in Cornell University.

Work has begun on the foundation for the five-story building of the Hunterian Laboratory connected with Johns Hopkins Medical School. The new building is located at the corner of Wolfe and Madison Streets, will be 50 by 100 feet and will cost about $65,000.

New York University has added to its graduate school courses in surgery by which it will be possible for graduate students to secure the advanced academic degrees of master and doctor of science. The course does not deal with the technique of surgical practise but with subjects such as the application of biological science to surgical diagnosis and therapy.

Mr. James Cole Roberts, of the United States Bureau of Mines, Denver, has been appointed to the Joseph Austin Holmes professorship of safety and efficiency engineering in the Colorado State School of Mines.

Dr. Robert S. Morris, formerly of the Johns Hopkins University, has been appointed to the Frederick Forchheimer chair of medicine in the medical department of the University of Cincinnati.

Dr. Robert H. Mullin, director of the laboratories of the Minnesota State Board of Health and assistant professor of pathology and bacteriology at the University of Minnesota, has accepted an offer from the University of Nevada, at Reno, to take charge of the hygienic laboratories of that institution.

Dr. H. G. Earle has been appointed professor of physiology at the University of Hong Kong.

Dr. Hermann Jordan, docent in Tübingen, has been called as associate professor of comparative physiology in Utrecht, as successor to the late Professor A. A. W. Hubrecht.

Professor Benecke, of the Berlin Agricultural School, has been called to the chair of botany at Münster, as successor to Professor Correns.

Dr. Boris Zarnik, associate professor at Würzburg, has accepted the professorship of zoology at the University of Constantinople.

DISCUSSION AND CORRESPONDENCE

ELECTROMOTIVE PHENOMENA AND MEMBRANE PERMEABILITY

In his very interesting presidential address, printed in Science, Professor Bayliss[1] discusses among other things the origin of electromotive forces in living cells. In this discussion Professor Bayliss adopts the theory, originally suggested by Ostwald and elaborated by Bernstein, R. Lillie and Höber, that the E.M.F. observed in living tissue is due to a selective ion permeability in the sense that normally only cations are able to diffuse through the membrane, but that if the membrane is injured or if a cell is active its membrane becomes also permeable for anions. As a consequence of this increase in permeability the spot where this happens must become negative if compared with a spot of normal or resting tissue. To quote Professor Bayliss:

> I referred previously to the electrical change in excitable tissues and its relation to the cell membrane. It was, I believe, first pointed out by Ostwald and confirmed by many subsequent investigators, that in order that a membrane may be impermeable to a salt it is not a necessary condition

[1] Science, 1915, N. S., XLII., No. 1085, p. 509.

that it shall be impermeable to both the ions into which this salt is electrolytically dissociated. If impermeable to one only of these ions, the other, diffusible, ion can not pass out beyond the point at which the osmotic pressure due to its kinetic energy balances the electrostatic attraction of the oppositely charged ion, which is imprisoned. There is a Helmholtz double layer formed at the membrane, the outside having a charge of the sign of the diffusible ions, the inside that of the other ions. Now, suppose that we lead off from two places on the surface of a cell having a membrane with such properties to some instrument capable of detecting differences of electrical potential. It will be clear that we shall obtain no indication of the presence of the electrical charge, because the two points are equipotential, and we can not get at the interior of the cell without destroying its structure. But if excitation means increased permeability, the double layer will disappear at an excited spot, owing to indiscriminate mixing of both kinds of ions, and we are then practically leading off from the interior of the cell, that is, from the internal component of the double layer, while the unexcited spot is still led off from the outer component. The two contacts are no longer equipotential. Since we find experimentally that a point at rest is electrically positive to an excited one, the outer component must be positive, or the membrane is permeable to certain cations, impermeable to the corresponding anions. Any action on the cell such as would make the membrane permeable, injury, certain chemical agents, and so on, would have the same effect as the state of excitation. If we may assume the possibility of degrees of permeability, the state of inhibition might be produced by *decrease* of permeability of the membrane of a cell, which was previously in a state of excitation owing to some influence inherent in the cell itself or coming from the outside. This manner of accounting for the electromotive changes in cells is practically the same as that given by Bernstein.

The suggestion of Ostwald was questioned by physical chemists, *e. g.*, Walden, Tammann and Nernst. Recent experiments carried on in the writer's laboratory have shown that the attempt to explain the E.M.F. in tissues by the idea of a selective ion permeability and its changes (which the writer had originally also adopted) is neither tenable nor necessary. Space permits to point out only a few of the reasons for this statement.

1. Loeb and Beutner found that if we lead off from two places on the surface of an intact plant leaf (*e. g.*, rubber plant) or fruit (*e. g.*, apple) with two solutions of the same electrolyte but of different concentration, the lower concentration is always positive to the higher; and the E.M.F. depends upon the ratio of the two concentrations as expressed by Nernst's well-known formula. In the most ideal objects for this purpose the E.M.F. corresponds quantitatively to Nernst's formula. In all cases a spot of tissue (no matter whether plant or animal) in contact with distilled water is positive if compared with a spot in contact with a physiological salt solution or a Ringer solution.[2]

According to the theory of Bernstein, which Bayliss adopts, a spot of muscle or leaf in contact with distilled water should be negative to a spot in contact with a physiological salt solution, since we know that distilled water causes an increase in permeability. This increase in permeability is shown not only by the facts of cytolysis, but also by direct observations on the eggs of *Fundulus* in the writer's floating experiments. Thus one of the most general phenomena in electrophysiology contradicts the theory of selective ion permeability.

The experiments of Beutner and of Loeb and Beutner have shown that the E.M.F. which appear at the surface of living tissues can be imitated if we bring a watery salt solution in contact with a substance immiscible in water, such as lecithin or oleic acid (which for experimental purposes was dissolved in guaiacol).[3] According to Beutner's theory[4] traces of the salts are soluble in the water immiscible phase and one ion combines here with an anion or cation (or both combine in the case of an amphoteric electrolyte). The common ion of the salt in the water and of the water immis-

[2] Loeb, J., and Beutner, R., *Biochem. Ztschr.*, 1912, XLI., p. 1.

[3] Loeb and Beutner, *Biochem. Ztschr.*, 1913, LI., p. 288; 1914, LIX., p. 195.

[4] Beutner, *Ztschr. f. physik. Chem.*, 1914, LXXXVII., p. 385; *Jour. Am. Chem. Soc.*, 1914, XXXVI., pp. 2,040 and 2,045.

cible salt determines the E.M.F. On the basis of this assumption Beutner has been able to explain the observed phenomena thermodynamically, and his theory accounts for all E.M.F. at phase boundaries.

It follows from this theory that a spot of tissue in contact with distilled water should be positive to one in contact with a physiological salt solution, which is actually the case.

It was known that if we lead off from two spots of a muscle with a KCl and NaCl solution of the same concentration, the spot in contact with KCl appears negative to that in contact with NaCl. Loeb and Beutner could show that this was also true for the boundary between oleic acid or lecithin and salt solutions, and it was explained by Beutner on the assumption (which could be verified) that KCl is more soluble in the water immiscible phase than NaCl, that the Cl combines with some constituent of the water immiscible phase, and that the Cl ion, being the common ion, determines the E.M.F.

2. It is well known that an injured spot of a tissue is negative to a non-injured spot (current of injury), and this is explained on the basis of Bernstein's or Bayliss's theory by assuming that the specific cation permeability of the membrane is abolished by the injury and that the anions will also reach the outer boundary of the injured spot. Loeb and Beutner have published experiments which show that the so-called current of injury has nothing to do with an alteration of permeability, but that it is in all probability due to the existence of an internal E.M.F. situated at the internal boundary of the membrane.[5] If it is true that the junction of the outer boundary of an organ, *e. g.*, an apple, with a salt solution must become the seat of an E.M.F., the same must be true for the boundary of the membrane with the internal liquids of the tissues containing electrolytes. If we could show that this internal E.M.F. is generally smaller than the E.M.F. at the outside surface when we lead off from the latter with a physiological salt solution, the so-called current of injury would find a simple explanation. As a matter of fact, acids, KCl, and other substances give rise to negative potentials if compared with that of a physiological salt solution of the same concentration, and it is quite possible that such a solution exists at the inner boundary of the membrane. When we lead off from two intact spots on the surface of an organ we do not notice the existence of the internal potentials, since they are opposite and equal; but if we destroy the membrane on one spot and lead off from this spot and from an intact spot of the skin the injured spot must be negative to the normal spot, since in reality we measure in this case the difference between the outer and the inner potentials of the membrane. The idea that such a layer exists at the internal surface has received support by a series of experiments by Loeb and Beutner, some of which may be mentioned. When we cut an apple in two and lead off with salt solutions of the same kind and concentration from the intact outer surface and from the cut, the cut is negative, as was to be expected. When we remove more and more of the flesh of the apple, while leaving the skin unaltered, the difference of potential between outside skin and cut surface at first remains unchanged; but if we remove so much that the salt solution (with which we lead off from the cut surface to the measuring instrument) reaches the internal surface of the rind, the E.M.F. between the intact and injured part of the apple becomes less and finally disappears. In this case the salt solution replaces, in our opinion, the natural layer of liquid on the inner surface of the skin.

When we press the skin of an apple on one spot with the soft part of our finger without causing an abrasion of the skin, that spot becomes negative to a non-pressed spot; and yet we can show that the permeability of the skin is intact. This can be shown by the fact that the concentration effects produced by applying solutions of different concentrations are still the same as in any intact part of the skin; while this is no longer the case if we cause an abrasion. The explanation which we ventured to give for the fact that the pressed spot be-

[5] Loeb and Beutner, *Biochem. Ztschr.*, 1912, XLIV., p. 304.

comes negative was that the pressure displaces the layer of acid or any other substance which may be responsible for the inner potential, and replaces this substance by the juice pressed out from some of the soft cells of the flesh of the apple, but without altering the permeability of the skin.

Under these conditions the fact that the active part of a tissue becomes negative to a part at rest finds its simple explanation on the assumption that in the active part of the tissue substances are formed which temporarily alter the potential at the inner surface in such a sense as to make the outside on that spot appear more negative. There is no necessity for assuming any increase in the permeability of the skin.

JACQUES LOEB
THE ROCKEFELLER INSTITUTE FOR
MEDICAL RESEARCH,
NEW YORK

WHAT IS HELLENISM?

IT would usually be both foolish and ungrateful to criticize the choice of illustrations used by a lecturer in an attempt to make clearer a worthy proposition. When, however, the illustration is in very common use, though more often in another manner, when it is sure to remain in common use, and when moreover it has great and positive value, its misuse is dangerous enough to merit attention. The address of Professor Harrison, published in SCIENCE of October 23, 1914, urges us to make science of practical value. We may all well do what we can to share and spread the motive and accomplish its aim. In this address, Professor Harrison contrasts Hellenism and Hebraism, apparently in the sense that Hellenism typifies clear thought, and Hebraism vigor in practise. We are all familiar with the contrast of Greek and Hebrew culture, in which the former represents reason, and the latter faith, as the guiding principle of conduct. Professor Harrison's contrast strikes me as both novel and unsound.

The Hellenic culture which has influenced subsequent civilization was essentially the culture of Athens. The usual idea of Athenian culture is that it was characterized by marvellous activity. As to the culture typical of Athens, we can go back to the greatest Greek historian, and as to Greek ideals, to the greatest Greek philosopher, both of them men whose works are still commonly regarded as preeminent in their fields. The opinion of Thucydides with regard to the Athenians is expressed over and over. In Chapter III. of Book I., he puts his views into the mouth of the envoy of Corinth, who is addressing an assembly in Sparta:

> The Athenians are addicted to innovation, and their designs are characterized by swiftness alike in conception and execution; you have a genius for keeping what you have got, accompanied by a total want of invention, and when forced to act you never go far enough. Again, they are adventurous beyond their judgment, and in danger they are sanguine; your wont is to attempt less than is justified by your power, to mistrust even what is sanctioned by your judgment, and to fancy that from danger there is no release. Further, there is promptitude on their side against procrastination on yours; they are never at home, you are never from it: for they hope by their absence to extend their acquisitions, you fear by your advance to endanger what you have left behind. They are swift to follow up a success, and slow to recoil from a reverse. Their bodies they spend ungrudgingly in their country's cause; their intellect they jealously husband to be employed in her service. A scheme unexecuted is with them a positive loss, a successful enterprise a comparative failure. The deficiency created by the miscarriage of an undertaking is soon filled up by fresh hopes; for they alone are enabled to call a thing hoped for a thing got, by the speed with which they act upon their resolutions. Thus they toil on in trouble and danger all the days of their life, with little opportunity for enjoying, being ever engaged in getting: their only idea of a holiday is to do what the occasion demands, and to them laborious occupation is less of a misfortune than the peace of a quiet life. To describe their character in word, one might truly say that they were born into the world to take no rest themselves and to give none to others.

The ethics of Aristotle represents happiness as the goal of human effort, and work as absolutely indispensable to happiness. No single quotation would give an adequate idea of the

insistency with which the importance of activity is emphasized. Even where amusement is recognized as sometimes worth while, and rest as sometimes necessary they are countenanced only because constant work is, in experience, impossible.

Rest, therefore, is not an end, because it is adopted with a view to working afterwards.

Happiness itself is repeatedly defined as "a working in the way of excellence." When Aristotle finds the highest happiness in intellectual contemplation, he explicitly justifies himself on the ground that intellectual contemplation is itself the exercise of the highest of human faculties, of that of the mind. Aristotle hardly pauses upon this point, before he goes forward to point out that the thoroughly wise man must proceed, if he would achieve all the happiness within his reach by making his wisdom effective, to do exactly what Professor Harrison is urging, to interest himself in public affairs, and thus find for his wisdom the greatest possible usefulness. The politics and ethics of Aristotle are tied together by this dependence of the highest happiness of the truly wise man upon public activity.

With the Greek historian and the Greek moulder of the world's thought on record as they are, it would be superfluous to quote, as might be done, from many other Greeks; and Greek history is too generally familiar to make it worth while to refer to the wealth of Greek achievement. As the histories of the two people are usually read, Hebrew culture and history were, in comparison with the Greek, nothing but an almost unbroken oriental slumber. The single great Hebrew achievement was the enunciation of faith.

Greek ideals are constantly urged, and Greek examples constantly held before us. If we were to let ourselves imagine that the acceptance of these ideals and these examples involve any kind of inactivity, it would be a calamity. The trend of human views and human ideals has for a long time been away from the Hebrew, and toward the Hellenic. It is not Hebraism which is just now "exuberant." There is rather too little willingness in the world to-day to trust any light, if its source lies beyond our reach. But it is a most imperfect form of Hellenism which is "exuberant." Greek activity was intellectual enough to keep its aims, even the most ultimate, fairly well in view. A very large part of modern activity is so blind to any aims, except the most immediate, that it has no means of testing the validity and worthiness of even such aims as are within its vision. Greek thought kept happiness in view as the goal of effort, and examined this goal with such care that Greek opinion concerning it is very generally held to-day by those who are familiar with Greek opinion. Modern thought has added amazingly little to Greek views.

Knowledge has been making amazing strides. But aside from medicine, modern knowledge contributes infinitely less than it should to the attainment of the ultimate goal. I do not know that the world was happier at any past time than it is now, but am very sure that there is very far from being the happiness now that there ought to be. The advance in knowledge during the past half century has not been accompanied by any corresponding development of happiness. Indeed, we do need to exert ourselves to make our knowledge worth while. We should study to understand what happiness is, and how we can make our activities effective in achieving it. When we do this, each in such measure as he can, we shall act according to the best Hellenic ideals, ideals not merely held by the Greeks, but expressed by them more perfectly, I believe, than has ever been done since.

E. B. Copeland

College of Agriculture,
Los Baños, P. I.

UNIVERSITIES AND UNPREPAREDNESS

The majority of persons are so absorbed in the events of the European war that little attention is paid to the consideration of methods by which this nation could coordinate and use its intellectual resources to the best advantage in making some positive contribution towards the rehabilitation of civilization. We should expect the universities to be keenly alive to the necessity for supplying the leaders of

thought essential in preparing the way for a new era, but these institutions are seriously hampered by a narrow provincialism and are generally quite willing to sacrifice national interests to the interests of their own alumni.

The following letter has been written in the hope that those who read it may be induced to express their views upon the methods available for curing our universities of that infirmity of spirit which is a symptom of the national malady of general unpreparedness for either war or peace.

PRINCETON, N. J., October 1, 1915.

Dear Sir: The present crisis in civilization has brought this country face to face with many new and grave responsibilities. We have suddenly awakened to an increased sense of appreciation of the need of adequate protection against invasion, of greater facilities for insuring the scientific development and extension of industry and commerce, of promoting research and scholarship, and of eventually developing a culture which will contain dynamic power sufficient to hasten the spread of the spirit of malice towards none and charity for all.

The people of the United States are now vaguely considering the possibility of making a contribution of permanent value to the cause of civilization, but substantial progress in this direction can only be gained under other standards of leadership, and by the dissemination of higher ideals than those hitherto exhibited by older civilizations. The task is an enormous one. Advance towards a newer civilization will tax human intelligence to the uttermost.

What active preparation are our universities making to assume their share in this great movement?

An extraordinary opportunity exists—one rich in possibilities, not only for coordinating but for strengthening the intellectual forces of the nation. World-problems must be solved in a world-spirit. Is not this the moment to break away from the narrow provincialism which interferes with the active participation of our universities in the general advance?

This provincialism is manifested in the form of administration of university affairs which allows the imposition of ideals entertained by those alumni who appraise the value of their alma mater in terms of sentimental attachments without considering the relation of the institution to the nation and to the intellectual life of the people.

For some years I have been trying to analyze conditions which seem to handicap the universities seriously in their effort to stimulate and direct the thought of the nation. In this connection I should consider it a favor if you would reply to the following questions:

1. Can you suggest a method by which a freer interchange of opinion and criticism between universities might be effected?

2. How can we combat the obsessions and overvalued ideas that are the common accompaniments of emotional reactions associated with athletic contests and which make it extremely difficult to substitute the national for the provincial ideal in university administration?

3. Do you believe that a broader and more intelligent spirit would be introduced into the administration of affairs if the principle was carried into practise of adding faculty representatives, including those from other universities, to each board of trustees or overseers?

4. Have you any suggestion to offer in regard to the changes in the present form of organization so that the administration of the finances and the formulation of the educational policy should not be under the control of a single board of trustees?

Thanking you for the courtesy of a reply, I am,

Respectfully,

STEWART PATON

PRINCETON, N. J.

SCIENTIFIC BOOKS

The Mutation Factor in Evolution with Particular Reference to Œnothera. By R. RUGGLES GATES, Ph.D., F.L.S. London, 1915. Macmillan and Co. Pp. xiv + 353. Price $3.25.

Dr. Gates has been a prolific contributor to the already very extensive literature on œnotheras, and this book will be a welcome summary of his views as expressed and modified through a long series of papers.

Following the "Introduction" is a chapter, accompanied by a map, on the "Character and Distribution of the Œnotheras," in which structural features and life habits are described and a list of twenty-eight species given with synonymy and accounts of their distribution. The fact that twelve species are appended to this list without discussion indicates how rapid is the progress being made, chiefly through the studies of Bartlett, to our knowledge of the

Œnothera taxonomy and how circumscribed is our present horizon. Every years adds some new species which have been tested in the experimental garden, the only safe way of determining for most of the œnotheras their true characters and justifying the publication of species. With these conditions in the group some years must elapse before we shall be in a position to take a general survey of the field.

A chapter on "The Cultural History of Œnothera" presents an interesting account of the pre-Linnæan references to œnotheras with a number of figures reproduced from old works. This account leads up to a discussion of the origin and status of *Œnothera Lamarckiana*, a matter of fundamental significance in any consideration of the value of this plant as representative of a mutating species. Gates accepts without qualifications the opinion of De Vries that *Lamarckiana* was collected in America by André Michaux about the end of the eighteenth century. The evidence for this view rests on a specimen in the Muséum d'Histoire Naturelle at Paris. The photograph of this plant published by De Vries and only figured in part by Gates shows a plant with narrow-lanceolate leaves strongly petioled, narrow bracts, and very long sepal tips. That this plant could have been related to *Lamarckiana* with its ovate-lanceolate leaves almost sessile, broader bracts, and shorter sepal tips seems to me scarcely possible, and I venture to believe that neither Bartlett nor Shull, both *Œnothera* specialists, will follow De Vries in this identification.

Accepting this identification of De Vries, Gates finds no difficulty in believing that *Lamarckiana*, as a native American species, established itself on the Lancashire coast of England previous to 1800, and that the figure of Sowerby, 1806, is of this plant in spite of the fact that the flowers as drawn are not so large as those of *Lamarckiana*, the position of the stigma not so high, and that no mention is made in the description of the very conspicuous red papillæ upon the stem. An alternative possibility that the plant of Sowerby was a form related to *biennis* finds no favor with Gates. The chapter concludes with accounts of a number of races of *Lamarckiana* now in cultivation or otherwise recognized. Gates accepts with De Vries the suggestion that the source of the *Lamarckiana* introduced into cultivation by Carter and Company about 1860 may have been not Texas, as they state, but England.

Chapters IV. and V. give descriptions of the "mutation phenomena" in *Lamarckiana* and other species and include observations of his own as well as those of De Vries and other authors. There is also described in these chapters the results of many breeding experiments involving the "mutants" as parents. These chapters should be read with the following points in mind as reservations of prime importance for judgment on the deductions. Recent work has shown that the germination of very many seeds of œnotheras is usually delayed far beyond the time generally allowed by the preservation of seed pans. Although the facts of delayed germination and seed sterility have been recognized, few investigators have taken the trouble to make counts of the seeds sown and until recently none have obtained complete germination as established by experimental methods properly checked through the examination of the residue of sterile seed-like structures. Consequently we can not feel confident that the records of any cultures of *Œnothera* so far reported are complete for their possible progeny. The percentages calculated for "mutants" and the ratios of classes in breeding experiments can not be accepted as final in exact genetical work. We are not in a position even to guess what may be the changes of front when exact data become available.

In Chapter VI., on the "Cytological Basis of the Mutation Phenomena," will be found an account of Gates's own contributions in cytology which have been noteworthy. A good description of the reduction divisions in the pollen mother-cells paves the way for the discussion of irregularities in the distribution of chromosomes whereby gametic nuclei may be formed with more or with fewer chromosomes than 7, the normal number. From such gametes, fertile zygotes are occasionally formed that give rise to œnotheras with high counts of chromo-

somes of which the *lata* and *semi-lata* types with 15, the *semi-gigas* with 21 and the *gigas* with 28 chromosomes, respectively, are the best known. Gates gives a clear account of his important studies on *lata* and comprehensive discussions of triploidy and tetraploidy, the latter with a long list of genera with species in which the chromosome number has been doubled. It is not likely that there will be disagreement with Gates's chief conclusion that the characters of these plants are correlated to some extent with the peculiarities of their chromosome counts, which are above the normal 14, and that some of the variants from *Lamarckiana* and other species, called "mutations" are due to irregularities in the distribution of their chromosomes.

However, certain features of the chromosome behavior at the time of reduction in the species studied by Gates are not discussed from all points of view. Gates emphasizes the fact that in the œnotheras studied by him the pairing of the chromosomes previous to the reduction division is very loose, so that mechanical arrangements favor the irregularities of distribution which actually occur. In these observations other students of *Œnothera* cytology agree for *Lamarckiana* and some of its "mutants" and for certain other forms. But Gates assumes that this peculiarity, *i. e.*, a loose pairing of chromosomes, is a condition prevalent among œnotheras in general, including those which he believes to be pure species, and that the forms of this genus depart from the rule, supported by an overwhelming mass of evidence, that in pure species there is a very exact pairing of chromosomes previous to the reduction divisions. Studies among such animals and plants as have a series of chromosomes of different sizes and forms have shown a most remarkable association of these in strictly homologous pairs, and the presumption is justified that a pairing of homologous chromosomes at the time of reduction is the rule in pure species.

One *Œnothera* is known, namely, a line of *grandiflora*, in which the chromosomes following synapsis become associated very definitely into ring-shaped pairs which are assembled in a very orderly manner at the equatorial plate of the reduction division and are subsequently distributed in equal numbers by the separation of the members of each pair. This is a history entirely in accord with that generally reported for animals and plants and the conditions allow of little or no opportunity for irregularities of chromosome distribution. Now it also happens that the seeds of this line as recently tested are almost wholly fertile and that there is scarcely more than a trace of pollen sterility. In short, this line with respect to its fertility and to the regularity of its reduction process presents the behavior to be expected of a pure species. Since one line of *Œnothera* is regular in its behavior, there are probably other lines equally so, and these may prove to be the species purest of all the œnotheras in their genetical constitutions. They have not yet been studied either cytologically or through breeding experiments. On the other hand, *Lamarckiana* and certain of its derivatives, types of very low seed and pollen fertility, irregular in their reduction divisions, and extraordinary in their breeding habits, have been given much attention and assumed by the mutationists to be representative of pure species. In the face of these exceptional peculiarities the natural assumption until otherwise disproved should be that *Lamarckiana* and these derivatives are not pure species and that the irregularities of their cytological and breeding habits are the result of a hybrid constitution. This is a phase of the matter which Gates does not consider.

A long chapter on "Hybridization" and one on the "Relation between Hybridization and Mutation" discuss the nature of mutation crosses, Mendelian splitting, blending and modification of characters, twin hybrids, double reciprocal crosses, etc. There is summarized here the most important of Gates's breeding studies, including those between *grandiflora* and *rubricalyx*. So far as the statements of ratios and percentages are concerned, the criticism of course applies here as to all past *Œnothera* work that we have no assurance of complete results since there is no means of knowing what proportion of the seeds sown was fertile or how imperfectly representative

may have been the cultures due to incomplete germination. One can not feel confident that the results were more than glimpses of the genetical possibilities and under these conditions speculation loses its point. We are not likely to be in a position to discuss satisfactorily the problems of *Œnothera* genetics until new series of experiments are undertaken with methods whereby the germination of seeds is forced to a finish.

Gates makes an attack on the extreme views of certain Mendelian writers who have held so strongly to a principle of the conservation or fixity of factors that they do not allow of their modification even through crossing. It may be doubted whether this group of Mendelians is really a large one, but so far as they do exist the criticisms of Gates are likely to have the sympathy of his readers. It is, however, one thing to recognize the complexity and possible instability of protoplasm as to its stereochemistry and quite another to hold that stereochemical changes within a pure species can produce such great modifications of morphological structure as the mutationists would have us believe. And the œnotheras are so strongly under suspicion of genetic complexity through hybridism that we have a right to expect that evidence for mutation from this group will be most critically sifted and only employed where it is found in material of proven purity.

One may be Mendelian, firmly believing in the principle of segregation following an F_1 generation which is the principal tenet of Mendelism, and still admit the probability of modifications from time to time of the stereochemistry of germ plasm even in so-called "pure lines." That such changes may result in spontaneous modifications of structure seems reasonable on philosophical grounds and such modifications would constitute mutations since they are discontinuous. But it remains to be proven that such modifications affect changes in morphology to the degree claimed by the mutationists, although it may well be possible that numerous small mutations would in time have a cumulative effect readily recognized. Thus advances in evolution may come about through numerous small steps, as held by Darwin, and some of these may be mutations, but it seems probable, as so strongly argued by Weismann, Lotsy and others, that the chief causes of variation in higher animals and plants and the most important directions of evolution are determined through the mixing of diverse germ plasms with their complex interactions. Modifications of germ plasm through crossing, and mutations due to external chemical and physical factors, would be expected at times to work simultaneously, and in such cases it may become a difficult matter to distinguish their separate effects. Mutations even though small in degree would, however, if sufficiently numerous, work in time profound modifications of structure, and on this common ground the mutationists and the followers of Darwin seem to have the strongest hopes of reaching an agreement.

The final chapters, "A General Theory of Mutations" and "The Evolutionary Significance of Mutations," continue and elaborate the discussion which runs through the previous pages and thus largely summarize or expand the author's views. A bibliography of about 500 titles, of which 42 are by Gates, completes the work.

Bradley M. Davis

A Text-book of Zoology for Universities, Colleges and Normal Schools. By Thomas Walton Galloway, Ph.D., Litt.D., Professor of Biology in the James Millikin University. Third edition, revised. P. Blakiston's Son & Company, Philadelphia.

It fell to the lot of the present writer to undertake a review of the first edition of this book[1] which was published in 1906. In paper, typography, binding, etc., the book is well made and attractive to look upon, a very deserved compliment to the publishers, who seldom allow anything inferior in the way of bookmaking to emanate from the house.

Intrinsically there is little change over the first edition, aside from the addition of some four chapters comprising about sixty-five pages more than the former book. The same plan

[1] Science, Vol. XXIV., p. 719.

of treatment which characterized the former has been continued. A slight change in the title, the former having been "A Text-book for Secondary Schools, Normal Schools and Colleges," may possibly reflect somewhat of the well-meant criticism of the reviewer, possibly some slight change of attitude on the part of the author, touching the attempt to comprise so large a scope of utility for a single book. The principal feature of the new edition calling for mention is that comprising the added chapters already referred to. These the author designates a "third part, a group of synthetic chapters (XXVI.–XXIX.) to induce the student to gather up the details of his course by a new reorganization of the materials." The captions of the chapters will indicate their scope. Chapter XXVI., "The Doctrines of Evolution and Related Ideas," among which are heredity and Mendelism. Chapter XXVII., a very interesting one, is devoted to "Economic Zoology," including such features as "Animals as a Food Supply, Animals as a Source of Clothing for Man, Animals in Science and Medicine," etc. Chapter XXVIII., "Development of Zoology," is a brief summary of the history of zoology, including the "Greek and Roman Periods, the Middle Ages, Modern Period and Its Specializations," and ending with sections of the "Philosophy of Biology, and Applications of Biology."

It is a matter of regret that some of the errors pointed out in the previous edition have been allowed to go uncorrected. For example, the obvious error in the description of expanded and contracted conditions of *Vorticella* in Fig. 70 (68 of the first edition). Perhaps the error was so obvious as to be regarded beyond the necessity of correction, assuming that every one concerned would make it for himself! Again, the pleasing bit of biological fiction involved in the symbiotic relations of certain hydroids and the hermit crab, that "the polyps cover up the shell occupied by the crab, thus concealing it from its enemies and its prey," the unwarranted assumption of which was shown in the former review, remains in spite of reviewer, or well-known facts to the contrary. In this connection may also be pointed out that the illustrations of hydroid ontogeny shown in Fig. 84 are likewise of extremely doubtful validity, as are also other features in connection with the treatment of the cœlenterates.

In conclusion the reviewer would incline to question the assumption of the author (Preface, p. v) "that the right text-book of zoology, as of every other subject, is primarily a matter of psychology." It would be futile to discuss this proposition in this connection, but it seems fairly evident that there may be intrinsic and inherent principles which determine, quite as much as any psychological quirks, the method and content of a zoological text-book.

C. W. H.

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The tenth number of Volume 1 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *The Octopus Motive in Ancient Chiriquian Art:* George Grant MacCurdy, Peabody Museum, Yale University.

After discussing general features of animal motives in Chiriquian art, the octopus motive, which appears hitherto not to have been identified, is traced through a number of varying forms in vases, of which six are figured in cuts.

2. *The Life Cycle of Trypanosoma brucei in the Rat and in Rat Plasma:* Rh. Erdmann, Osborn Zoological Laboratory, Yale University.

The method employed affords the means of following, outside the body of the host, the sequence of changes in the life of trypanosomes, and its use has shown dimorphic forms, latent or round, and crithidia-like forms in *Trypanosoma brucei* outside of the host.

3. *The Effect of Pressure on Polymorphic Transitions:* P. W. Bridgman, Jefferson Physical Laboratory, Harvard University.

This note presents, in a compact form by means of diagrams, many of the essential facts concerning the effect of high hydrostatic pres-

sure on the polymorphic transitions of 30 substances.

4. *On Isothermally Conjugate Nets of Space Curves:* Gabriel M. Green, Department of Mathematics, Harvard University.

A necessary and sufficient condition that a conjugate net of curves on a surface be isothermally conjugate is that at each point of the surface the pair of axis tangents, the pair of associate conjugate tangents, and the pair of anti-ray tangents be pairs of the same involution.

5. *The Rôle of the Liver in Acute Polycythaemia: The Mechanism Controlling the Red Corpuscle Content of the Blood:* Paul D. Lamson, Pharmacological Laboratory, Johns Hopkins University.

There is in the body a mechanism for regulating the red corpuscle content of the blood; this mechanism is under nervous control, responding to nervous, chemical and emotional stimuli; the adrenal glands play a part in this mechanism, and the liver is the seat of the changes which increase the number of red cells, partly by a reduction in plasma volume, and partly by bringing cells into the circulation which are not normally present.

6. *The Potentials at the Junctions of Salt Solutions:* Duncan A. MacInnes, Laboratory of Physical Chemistry, University of Illinois.

The author calls attention to the fact that the liquid junction potential E_L of a concentration-cell of the type $Ag + AgCl$, $KCl(C_1)$, $KCl\ (C_2)$, $AgCl + Ag$ can be derived from measurements of its electromotive force E and of the cation-transference number n_c with the aid of the equation $E_L/E = (2n_c - 1)/2n_c$. This equation involves only the assumption that the work attending the transfer from one concentration to the other of one equivalent of ion is the same for the cation as for the anion. The author substantiates this assumption by showing that this equation, when applied to the electromotive force data of Jahn, leads to nearly the same values of $E - E_L$ (which should equal the difference in the two electrode-potentials) whether the electrolyte be KCl, NaCl or HCl.

7. *A Statistical Study of the Visual Double Stars in the Northern Sky:* Robert G. Aitken, Lick Observatory, University of California.

At least one in every 18, on the average, of the stars as bright as 9.0 magnitude in the northern half of the sky is a double star visible with the 36-inch telescope. Close visual double stars are relatively more numerous in the Milky Way than elsewhere in the sky, and visual double stars as a rule revolve in relatively small orbits. Close visual double stars are rare among stars of either very early or very late spectral class.

8. *Walnut Mutant Investigations:* Ernest B. Babcock, Division of Genetics, Department of Agriculture, University of California.

The mutation takes place in female flowers only and appears in the first generation after the mutation occurs but on crossing with the species type it is completely recessive in the F_1 generation and the nature of the mutation is such that only certain genetic factors are affected without having the chromosome number disturbed.

9. *Hereditary Fragility of Bone:* C. B. Davenport and H. S. Conard, Carnegie Institution of Washington and Grinnell College, Iowa.

Of a parent who early in life was affected with brittle bones at least half the children will be similarly affected, but if neither parent, though of affected stock, has shown the tendency, then expectation is that none of the children will have brittle bones.

E. B. Wilson

SPECIAL ARTICLES

ON THE OCCURRENCE IN THE SOUTHERN HEMISPHERE OF THE BASKING OR BONE SHARK, CETORHINUS MAXIMUS

Since it does not seem generally to be known that this giant elasmobranch is found in southern waters, it may be of interest briefly to give the following data which have been noted from time to time in the course of other ichthyological studies.

The old writers thought that this great beast was confined to the far north Atlantic and to the Arctic Ocean. Of these, Friedrich Faber

may be quoted. In his Natural History of the Fishes of Iceland he says:

> This giant among sharks [and he quotes Gunner that it grows to a length of 16 fathoms (Klaftern), but adds for himself that its ordinary length runs from 20–24 feet] is found only in northern seas and, moreover, is here not abundant.[1]

Goode and Bean in their monograph, "Ocean Ichthyology"[2] (1895) write:

> It is unknown elsewhere than in the north Atlantic, and south of the Grand Banks on the west, and Scotland on the east may be regarded as an estray.''

Jordan and Evermann (1896)[3] give it a more extended habitat since it is "found in Arctic waters, straying south to Portugal, Virginia and California." And later Jordan (1905)[4] in his "Guide to the Study of Fishes" notes that it occurs "on all northern coasts (and is) most frequently taken in the North Sea and about Monterey Bay, California." However, Bridge (1904)[5] in the Cambridge Natural History writes:

> Although generally described as a northern form, *Cetorhinus* is known to occur in Australian waters.

As might be expected from the well-known activity in ichthyological matters of the Australians, our southern references are mainly confined to the waters surrounding that continent.

Its occurrence in the antipodes was, so far as the present writer knows, first made known by Sir Frederick McCoy[6] in 1885. He figures and describes a large specimen taken at Portland on the west coast of Victoria in November, 1883. It was 30 feet 6 inches long and 20 feet in girth. He gives a very careful and minute description and very detailed measurements, the first and with one exception the only ones known to the present writer.

William Macleay,[7] whose paper was apparently published in the same year as McCoy's but slightly later, merely lists the basking shark in Australian waters on the authority of the latter, and gives no new data.

We next hear of *Cetorhinus* in 1901, when two specimens were taken at Eden, New South Wales, and were recorded by Mr. E. R. Waite in the following year.[8] Of the first specimen only a piece of "baleen" or gill-rakers reached Mr. Waite, but this was sufficient for its identification. However, in August, 1901, a young male 10½ feet long was taken at the same place and sent to the Australian Museum, Sydney.

A more extended account of the occurrence of this great shark in these southern waters is from the pen of Mr. J. A. Kershaw[9] of the National Museum at Melbourne, Australia. His specimen, which was a young male 12 feet and 11 inches long, was taken in Hobson's Bay near Williamstown, Victoria, in May, 1903. Mr. Kershaw gives a series of very full and carefully made measurements, the only one except McCoy's that seem ever to have been recorded. Its length lacked but one inch of 13 feet and its girth in front of the first dorsal was 3 feet 7 inches. Of Kershaw's careful description the most noteworthy point refers to the snout, which will be discussed later.

Stevenson (1904)[10] says that the basking

[1] Faber, Friedrich, ''Naturgeschichte der Fische Islands,'' p. 20. Frankfurt am Main, 1829.

[2] Goode, George Brown, and Tarleton H. Bean, ''Ocean Ichthyology,'' p. 22. Washington, 1895.

[3] Jordan, David Starr, and Barton W. Evermann, ''The Fishes of North and Middle America,'' Vol. I., p. 51. Washington, 1896.

[4] Jordan, David Starr, ''A Guide to the Study of Fishes,'' Vol. I., p. 540. New York, 1905.

[5] Bridge, T. W., ''Fishes'' in the Cambridge Natural History, Vol. VII., p. 453. London, 1904.

[6] McCoy, Frederick, ''Natural History of Victoria. Prodromus of the Zoology of Victoria,'' Decade XI., pp. 11–15, Plate 104, 1885.

[7] Macleay, William, ''Supplement to Descriptive Catalogue of the Fishes of Australia,'' *Proceedings Linnæan Society of New South Wales*, Vol. IX., pp. 62–63.

[8] Waite, E. R., ''New Records or Recurrences of Rare Fishes from Eastern Australia,'' Records Australian Museum, Vol. IV., p. 263, 1902.

[9] Kershaw, James A., ''Notes on a Rare Victorian Shark,'' *The Victorian Naturalist*, Vol. XIX., p. 62, 1903.

[10] Stevenson, Charles H., ''Aquatic Products in Arts and Industries,'' Report U. S. Fish Commission, Vol. XXVIII. for 1902, pp. 227–228, 1904.

shark is found on the coasts of Australia, Ecuador and Peru. So abundant are they in the latter region that a profitable fishery is carried on, their livers being utilized for oil. Stevenson quotes a Captain Baker, of New Bedford, that he took 125 barrels of basking-shark liver oil in 2 days. Stevenson further says that this great shark is reported to be taken at Kurrachee in northwest British India. All the authorities are agreed, however, that this latter shark is *Rhineodon typus*, the whale shark.

Last of all, Stead (1906)[11] notes that *Cetorhinus* is found on the coasts of New South Wales and Victoria, but not abundantly. This statement is probably based on the accounts of McCoy, Waite and Kershaw.

Even McCoy's notice is, however, *not* the first on the occurrence of this great shark in the South Seas, for Bennett (1840)[12] in his zoology of the voyage of the whaleship *Tuscan* tells us that:

While cruising in the south Pacific, we occasionally observed large animals which bore a great resemblance to whales (excepting that their tail-fin was perpendicular, and they did not spout), swimming near the surface of the sea. They appeared to be nearly 20 feet in length, and were called by the whalers bone-sharks, a name which implies little more than the very vague idea entertained of their true character. They are said to have whalebone in the mouth, yet do not spout; but partake of the nature of a shark, or other fish, and, like fish, can maintain a submarine existence for an indefinite time. They have been occasionally mistaken for whales, and harpooned by inexperienced whalers, when, taking away the line with irresistible impetuosity, they have disappeared in the ocean's depths, and left their assailants to watch in vain for their return to the surface.

Since whalers religiously avoid an encounter with these troublesome creatures, it follows that their real form and structure are but little known. If we admit that an error exists on the subject of there being whalebone in its mouth, it appears probable that the bone-shark is allied to, or is identical with, the Basking-shark (*Squalus maximus*), a fish, measuring from 15 to 30 feet in length, and which was formerly regarded as a species of whale.

Before bringing this note to a close, I wish to call attention to one other matter of importance. None of the observers save Kershaw correctly gives the shape of the snout. Günther (1880) indeed says

. . . young specimens have a much longer and more pointed snout than adults. . . .

And McCoy notes that it has a

fusiform head very small, abruptly narrowed to a short snout, with a slightly concave profile rising from a little behind the eye . . .,

all of which structures are shown in his figure, the snout appearing as a very weak and ineffective structure.

Goode and Bean (1895) merely say "snout blunt," and their figure, which is copied from Annales du Musée d'Hist. Nat. Paris, Vol. XVIII., pl. 6; and from Fish. Ind., pl. 249, upper figure, and which in turn has been widely copied (and is the only one save McCoy's known to the present writer), so shows it. Jordan and Evermann (1896), for example, simply copy Goode and Bean's text and figure. So practically does Bridge (1904). While Jordan (1905) calls it elephant shark but assigns no reason for the name.

Kershaw (1903) specifically notes that

. . . the front of the head is considerably extended, and forms a thick, fleshy, truncated snout, with the extremity produced into a curved fleshy hook, which altogether gives the fish a most extraordinary appearance.

This peculiarity, according to some earlier observers, occurs only in the young specimens, and has led to the erroneous opinion[13] that several different genera and species of basking sharks existed, an opinion which can hardly be wondered at considering the greatly different appearance this gives to the fish.

This specimen was a young one, only 12 feet 11 inches long; however, a year previous a fisherman had reported to Kershaw the capture in Melbourne Harbor of a large shark having "a long thick snout terminating in a hook."

[11] Stead, David G., "Fishes of Australia," pp. 233, 235, 236, 251. Sydney, 1906.

[12] Bennett, F. D., "Narrative of a Whaling Voyage Round the Globe, from the Year 1833 to 1836," Vol. II., London, 1840.

[13] Günther, A. C. L., "Introduction to the Study of Fishes," p. 323, Edinburgh, 1880.

The present writer has recently had an opportunity to examine in a traveling museum a mounted 36-foot specimen of *Cetorhinus maximus* taken in Monterey Bay, California. This had a thick and stout but very marked snout, bluntly conical in shape, which projected at least 15 inches in front of the upper jaw and from 18–20 inches over the lower jaw. It is interesting that such a marked structure should have so long escaped notice, but on the other hand opportunities to examine this giant shark come very rarely to properly trained naturalists. However, it seems from the above data that Jordan's name, elephant shark, is by no means a misnomer.

E. W. Gudger

State Normal College,
Greensboro, N. C.

LABELING CHEMICAL SPECIMENS

Probably every teacher of chemistry makes some use of samples of chemical elements and compounds in his lectures. In some cases, the set of specimens may have been purchased complete, in uniform style containers, with systematic and uniform labeling. Quite often, however, the additions to a chemical museum are made gradually, and as a result the collection may consist of all sorts, sizes and varieties of containers with an equally varied assortment of labels. When a set of specimens grows in this way, one can scarcely make use of serial numbers alone. An expansible system is necessary. The writer has used such a system for several years, with increasing satisfaction.

This labeling system has so far been used only for elements and inorganic compounds. It corresponds in principle to the usual library method of labeling books. A chemical catalogue of a leading firm was used as the source of the names. The list of chemicals being really quite comprehensive, it was possible to give a label number to the name of each substance one would ever be likely to include in a collection, writing these label numbers directly into the catalogue. The list of the chemical elements, in alphabetical order, was taken as the starting point. Names of elements beginning with the same letter are given serial numbers, as for example, magnesium is called M 1; manganese, M 2; mercury, M 3; molybdenum, M 4; aluminium, A 1; and ammonium compounds are placed under A 2. Specimens of the elements are labeled thus: Aluminium, A 1.0. When several kinds of samples of an element are included they are labeled thus: Aluminium, A 1.0 sh; aluminium, A 1.0 po; aluminium, A 1.0 le; the letters "sh," "po" and "le" stand respectively for "sheet," "powder" and "leaf." The method of labeling compounds may be illustrated by a few from the sodium list:

Sodium acetate, cryst.	S 6 a
Sodium acetate, fused	S 6 a 2
Sodium acid carbonate	S 6 ca
Sodium carbonate, dry	S 6 ca 4
Sodium chlorate	S 6 ch
Sodium chloride	S 6 chl
Sodium cyanide	S 6 cy
Sodium iodate	S 6 io
Sodium iodide	S 6 io 2
Sodium acid sulphate, powd.	S 6 su
Sodium acid sulphate, fused	S 6 su 3
Sodium sulphate, cryst.	S 6 su 4
Sodium sulphate, powd.	S 6 su 5
Sodium sulphide	S 6 sul
Sodium acid sulphite	S 6 sul 3
Sodium sulphite, cryst.	S 6 sul 4
Sodium sulphite, powd.	S 6 sul 5
Sodium sulphocyanate	S 6 sul 6
Sodium thiosulphate, cryst.	S 6 th
Sodium thiosulphate, powd.	S 6 th 2

Where omissions occur, as between "S 6 ca" and "S 6 ca 4," it is understood that other compounds or different forms of the same compound are to be supplied. These are, of course, to be found in the complete chemical catalogue.

From these examples it may be seen that the bottles, marked in this way, can always be kept in alphabetical order, and can scarcely be misplaced if the labels are read as to letters and numbers. Any sort of helper, who knows his alphabet and can count, will be able to take out specimens and replace them without confusion. New samples can be easily inserted anywhere, and given a label which shows exactly where it belongs.

No originality is, of course, claimed for this system of labeling, but the writer does not happen to know of its being used elsewhere for chemical specimens. Any one may easily devise letters and numbers to fit his present collection as well as future additions. Provision may be made for alloys, commercial samples, and the like, wherever necessary.

It is convenient to write the letters and figures in two lines, library style, as, "S 6" is written large with the "th 2" written small, beneath. Three figures, with the initial, will be the maximum number of characters in the first line. For the lower line, the rule is not to use more than three letters, while two figures will always be sufficient.

The bottles used in the writer's collection are one-pound and half-pound "salt mouth," of uniform style, with "mushroom" stoppers. These are convenient sizes, the smaller size being used mainly for the more costly substances. There are two labels on each bottle. The larger labels are known to the trade as No. 1006, about four by one and five eighths inches. The names of the substances are printed on these labels with rubber type in capital letters a quarter of an inch high. These labels are placed just below the shoulder of the bottle. The round labels used for the index letters and numbers are known as "A 88" or library labels. These are centered under the large label near the bottom of the bottle. A library assistant did the lettering of these labels, using india ink. The bottles are sealed with paraffin, and the labels coated with paraffin. The latter is necessary as the bottles are kept on open shelves, and usually require wiping with a damp cloth when they are to be shown. The paraffin further protects the labels against accidental contact with acids or alkalies.

This system of labeling is scarcely applicable to organic compounds, unless one does not wish to keep them separate from inorganic. The writer, for present purposes, has made a list of the substances studied or referred to, in order, in the organic text used (one of the most complete published), and each substance given a number. This does not include substances that are impracticable to keep or procure. The collection is so arranged that the substances mentioned in a given chapter are found together, in numerical order, the missing numbers to be supplied in the future. Another possible arrangement is by classes of compounds. This has been used, but is rather less convenient than the present arrangement. In the organic set, the half-pound bottle is the maximum size for solids, the two-ounce the minimum. For liquids, there are three sizes, from a half-liter down. The labels are No. 1007 for the names, and No. 539 for the numbers. The bottles are paraffined as in the inorganic set. On account of the effect of light on many organic compounds, the specimens are kept in a dark room, where the inorganic set is also kept for convenience.

The "looks" of one's teaching devices will be certain to leave lasting impressions on the observer. This is especially true in the chemical laboratory and lecture room. While it is not claimed that the above-described methods of labeling bottled chemical specimens are the best that could be devised, they have served the writer very well and it is hoped that the description may interest others.

C. E. Vail
Colorado Agricultural College

REPORT OF THE SAN FRANCISCO MEETING OF SECTION F OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. II

Thursday, August 5

Morning Session, Demonstrations

In charge of Olive Swezy, University of California

Entamœba Buccalis, Inez F. Smith, University of California.

Mitosis and Multiple Fission in the Flagellata, Olive Swezy, University of California.

Mitosis in *Lamblia muris*, Elizabeth Christiansen, University of California.

Enflagellating and Exflagellating Soil Amœba, Charlie W. Wilson, University of California.

Flagellates of Hemiptera, Irene McCulloch, University of California.

Drawings for Monograph on Dinoflagellata, C. A. Kofoid and Mrs. Rigden-Michener, University of California.

Drawings for Monograph on Pacific Tintinnoidea, C. A. Kofoid and Mrs. Elizabeth Purington, University of California.

Balantidium from the Pig, J. D. MacDonald, University of California.

Drawings of Elasmobranchs, J. Frank Daniels, University of California.

Papers: Protozoology

CHARLES A. KOFOID, University of California, presiding

Chromosomes in Protozoa: MAYNARD M. METCALF, Oberlin, Ohio.

This review has endeavored to show that in each group of the Protozoa are found elongated chromosomes which are linear aggregates of granules and which split longitudinally in mitosis, giving exact equivalence of the daughter nuclei. In all major groups, except perhaps the *Mastigophora*, presexual and sexual phenomena, essentially similar to those of *Metazoa* are known. The Metazoan mechanism of inheritance is therefore present, in some representatives at least, of all the great Protozoan groups. It has shown also that, in some representatives, at least, of the *Plasmodrome*, during the vegetative phases of the life history, the chromatin outside the caryosome, indeed apparently outside the caryoli, is thrown off as trophical chromidia. Such evolution of complexity of organization as has occurred in the *Metazoa* probably could not occur until, as in the *Ciliata*, a considerable amount of chromatin is kept intact throughout the whole life history, including its vegetative as well as its presexual and sexual phases. The lower Protozoa have the Metazoan type of mechanism of inheritance in connection with their sexual phases but can not utilize it for the development of a complex series of determiners for elaborate structural organization, for they do not keep this mechanism intact during their vegetative periods. The higher Protozoa apparently have the Metazoan type of mechanism of inheritance and keep it intact through all their life cycle. To what extent they have utilized its presence to develop determiners, is an interesting question which does not seem beyond experimental study with favorable material.

Problems on Rejuvenescence in Protozoa (illustrated with lantern slides): LORANDE L. WOODRUFF, Yale University (read by title).

The Evolution of the Protozoan Nucleus and Its Extranuclear Connections: CHARLES ATWOOD KOFOID, University of California.

The essential and fundamental similarity of Protozoan and metazoan nucleus is indicated by the general trend of recent cytological investigations among the Protozoa. The process of mitosis has the same sequence of phases, though the chronology of mitotic events and of the division of extranuclear structures varies from species to species and also among individuals within the species. In the early prophase in trichomonad flagellates and in *Nægleria* the chromatin aggregates, presumably chromosomes each split longitudinally, or the chromatin network forms a split skein or thread which later fuses into one, or emerges on the equatorial plate in chromosomes in which the precocious splitting has entirely disappeared. The chromosomes are definite in number and are differentiated among themselves as to size and behavior in mitosis. There are suggestions of odd and even numbers (4, 5) there is (in Trichomonad flagellates in several genera and species) a small chromosome lagging in the metaphase, and there are instances of unequal division of chromosomes.

The blepharoplast contains the centrosome in trichomonad flagellates or is attached to it (*Giardia-Lamblia*). This organelle should not be called a kinetonucleus; Schaudinn's report of its heteropole origin by mitosis is unsupported and probably invalid. It arises in enflagellating *Nægleria* (*-Amœba*) *gruberi* from the centrosome or centriole in the central caryosome, which sends out a radial fibril which enlarges at the periphery into a blepharoplast at the base of the two flagellæ which grow out from this enlargement. In exflagellation the flagella withdraw and together with the blepharoplast retreat into the caryosome. The blepharoplast is highly developed in parasitic flagellates and is directly connected by a system of fibrils with nucleus, flagella, axostyle and parabasal body, the whole forming an integrated structural unit which functions as a neuromotor apparatus comparable with that of the ciliate *Diplodinium*. It is a specialized structure developed to the greatest extent in connection with parasitic life demanding unusual expenditure of energy in locomotor activity. The term kinetonucleus should be abandoned as misleading. The Binuclearity Hypothesis in its nuclear implications has no adequate foundations, and the order Binucleata should be discarded. The parabasal body of flagellates and *Trichonyphida* is perhaps the analogue of the macronucleus of the ciliates and is an extranuclear store of the chromatin related to the needs of flagellar and ciliary activities.

Afternoon Session Papers: Geographic Distribution
JOSEPH GRINNELL, University of California, presiding

California as a Testing Ground for Theories of Distributional Control: JOSEPH GRINNELL, University of California.

Insect Transmission of Swamp Fever: J. W. SCOTT, University of Wyoming.

During the summer of 1914, the writer obtained experimentally a well-defined case of swamp fever, and the conditions of the experiment leave no doubt that the disease was contracted through the agency of certain biting insects. This disease, frequently known as "infectious" or pernicious anemia, is a serious and destructive blood disease of the horse. It has been reported from France, Germany and Japan, and is widely distributed in North America, from Texas to the Northwest Territories, and from the states of Washington and Nevada to the Province of Ontario, Canada. It has an altitudinal distribution from near sea-level to at least 9,000 feet. It is usually found in swampy regions, but has also been reported from rolling, wooded countries. Wherever found, it may become epidemic and cause the loss of a large percentage of a given herd of horses. The disease shows a seasonal distribution, reaching a maximum number of cases in late summer or early autumn. The disease itself is characterized by progressive emaciation and an intermittent rise in temperature; it is frequently accompanied by anemia, and the rises in temperature are sometimes at quite regular intervals. The organism is filterable, for the disease is transmitted by the injection of blood serum after it has been passed through a Berkfeld filter.

In France, Vallei and Carri concluded that natural transmisson took place through drinking water contaminated with urine or feces from an infected horse. Van Es, of North Dakota, in 1911, after a study of several years, thought this the most probable explanation. Swingle, however, in Wyoming, in 1912 and 1913, showed that it was an extremely difficult matter to secure infection by way of the alimentary canal, his numerous experiments with urine and feces all resulting negatively.

At this point in 1913 the writer began the problem. Since internal transmission was a difficult matter, only one or two cases being known (Van Es, Schlatholter), and since the contamination of drinking water could hardly explain epidemics, it was believed that natural transmission must be by means of some external agent. Accordingly in the spring of 1914 a screened cage was erected capable of holding five horses. The cage had an entryway 10 feet long, each end closed by a door and the screen had 16 meshes to the inch.

The first experiment in this cage was with various kinds of mosquitoes and resulted negatively. A longer and more conclusive experiment with mosquitoes the present summer has had a similar result. There was next introduced into this cage a considerable number of flies; these were house-flies, stable-flies and a few other wild flies, including one of the smaller species of Tabanids. The house-flies and stable flies thrived and increased rapidly in numbers between the first and the twenty-fifth of August; the other flies soon died and were not observed to attack the horses. The stable-flies were observed to feed in large numbers on both infected and well horses. Except for two or three days infected horses were kept continuously in the cage from July 27 to August 28. Three well horses were exposed in the cage during this time. On August 28 horse No. 22, a healthy strong animal, showed a temperature of 102.8. After two more fever periods this horse died October 5. Subinjection of his blood has produced typical cases, showing that he had the disease. The temperature of this horse had been normal from June 9 to August 28, and he had not been outside of the cage for 25 days, while 10–14 days is the ordinary incubation period of the disease. Under these conditions there appears to be no escape from the conclusion that insects transmitted the disease. It is believed further that the stable-fly was responsible for the transmission for the following reasons: (1) These flies were observed to attack the horses viciously. (2) Negative results of two other experiments show that the mosquitoes were not responsible, even though a few were still in the cage during August. (3) Houseflies do not bite, and the other flies present in the cage did not attack the horses, so far as one could observe, and soon died.

The experiment, with the stable flies alone, is being repeated, and another experiment involving some of the Tabanidæ is also in progress.

The Big Bears of Western North America, with Special Reference to their Distribution: C. HART MERRIAM, United States Biological Survey.

The bears are the largest of living carnivores and are widely distributed, being found in both Americas and in Eurasia. The typical genus *Ursus* occurs in both eastern and western hemispheres. South America is the home of *Tremarctos*,

a short-faced bear resembling *Arctotherium*, of the American Pleistocene, while the north polar regions are inhabited by the polar bear, *Thalarctos*. The ancestry of the bears is still clouded, none being known below the Pliocene.

Systematically the bears are a compact group, yet within the genus *Ursus* several subgroups may be recognized; the subgenus *Euarctos*, containing the black or cinnamon bears and the subgenus *Ursus*, containing the grizzly and brown bears. Of the latter (grizzly and brown bears) two, three and even four species, representing different species-assemblages, may be found in a single locality, as in the fossil deposits of Rancho La Brea or in Yellowstone National Park. The characters used in identification are chiefly cranial and dental. Skulls of males of the grizzly group are two, and in some cases, three times the bulk of those of females of the same species. At present about 40 species of grizzlies and 10 of brown bears are recognized, where formerly but one of each was known. For example, California once contained representatives of five different groups of grizzlies. The recognition of this large number of species has been made possible by the extensive collections of skulls in the United States National Museum and in the California Museum of Vertebrate Zoology.

Fossil Tertiary Mollusca of the Rocky Mountain Region: T. D. A. COCKERELL, University of Colorado, Boulder, Colorado.

The recent expeditions of the American Museum of Natural History, primarily for the discovery of mammalian remains, have brought to light some very interesting Tertiary land and freshwater shells, principally in Wyoming and New Mexico. From a study of these we are led to the following conclusions:

1. Certain of the most characteristic genera of the Rocky Mountain land shells living to-day are apparently very ancient inhabitants of the same general region, and have, perhaps, at no time extended very much beyond it. The most noteworthy example is *Oreohelix*, represented in the Eocene and Paleocene by large species, some of the specimens showing the sculpture of the apical whorls, which agrees with that of the group called *Radiocentrum* by Pilsbry. A species of *Holospira* from the New Mexico Paleocene is extremely like a living species of Arizona.

2. *Ashmunella*, one of the most characteristic endemic genera of the southwest, is not at present known below the Pleistocene. It is not possible to be sure, at present, whether all the peculiar genera of the Rocky Mountain region and southwest are very ancient inhabitants of that country, but it seems very likely that they will all be found, sooner or later, in the early tertiaries.

3. Various circumpolar genera of small snails, such as *Pupilla* and *Cochlicopa*, represented in the modern fauna by species identical or nearly identical with those of Europe and northern Asia, are apparently lacking in the Tertiary, or at any rate in the Eocene. They may have been overlooked, but it is probable that they have reached our region in much more recent times, from Eurasia, as their small amount of modification, or total lack of it, would suggest the Eocene collections do contain small species of more characteristically American types as *Vitrea* and *Thysanophora*.

4. The Paleocene and Eocene faunas included a series of genera entirely different from anything now living in the same region, but evidently related, at least in part, to the present Central American and West Indian faunas. Thus we have from the Eocene of Wyoming species apparently referable to *Pleurodonte* and *Eucalodium*. It is not clear, at the present time, whether this Central American fauna originated northward, or whether it had its main center in the region where it now exists, merely extending northward during a time when the country now represented by Wyoming and Colorado was low, moist and warm.

5. The most remarkable discoveries have been of small shells belonging to the Bulimulidæ, having the aperture or last whorl upturned, representing at least two genera (*Protoboysia* and *Grangerella*) and four species. These, while belonging to extinct genera, show evident relationship with some of the South American snails, and at the same time a remarkable resemblance to the Indian genus *Boysia*, which is supposed to belong to the Pupillida, though the anatomy is unknown.

6. Among the fresh-water shells, the Unionidæ are the most interesting. About the end of the Cretaceous and beginning of the Tertiary we find in the Rocky Mountain region a large and varied series, resembling the types which now inhabit the Mississippi Valley. At about the same time that the dinosaurs disappeared, these mussels also departed, leaving an impoverished Unionid fauna in the Eocene, which in its turn eventually died out altogether. It seems probable that this change was connected with earth movements.

Isolation as a Factor in the Evolution of Thais lamellosa (illustrated with specimens and lantern slides): TREVOR KINCAID, University of Washington.

Friday, August 6

Morning Session, Demonstrations

In charge of F. W. WEYMOUTH

Living Ova of Rat in Serum, J. A. Long, University of California.

Papers: Marine Zoology

F. M. MCFARLAND, Stanford University, presiding

The Occurrence and Possible Causes of Periodic Vertical Movements of Aquatic Organisms: C. O. ESTERLY, Occidental College, Los Angeles, California.

It is well known that many aquatic organisms, particularly those of the plankton, are more abundant at or near the surface by day than by night. This is because they ascend from deeper water in the early part of the night and descend from the surface later.

In order to understand the fundamental causes of this phenomenon it is necessary to have accurate knowledge of the field conditions under which collections are made, particularly of the temperature and salinity of the water and of the light intensity as represented by the time of day at least. It is highly important that field observations be supplemented by laboratory experiment to determine to what sorts and degrees of stimuli the organisms respond. Furthermore, each species must be studied by itself.

The explanation of the diurnal movement that at present is most satisfactory is the one based on responses to different factors in the environment, but our knowledge in this respect is very incomplete. The "mechanical explanation" which takes into account mainly the changes in viscosity of the water does not satisfy. The suggestion that the alternating rise and fall is due to metabolic rhythms has received so little attention that its worth is not apparent.

Some Physiological Characters of Marine Animals from Different Depths: V. E. SHELFORD, University of Illinois, Urbana.

Field Study of Animal Behavior as contrasted with Laboratory Study: ELLIS L. MICHAEL, Scripps Institute, La Jolla, California.

The object of this paper is to emphasize the necessity of employing two essentially distinct but mutually helpful methods of research in any strictly scientific study of animal behavior. All biologists readily admit that an important function of the well-known laboratory method is that of analyzing the mechanism involved in an organism's response. Few, however, seem to realize that this method is incapable of revealing how any particular species is related to its environmental complex.

Yet, the minute a definite answer to such a question is sought, a little thought clearly shows that recourse must be had to some method of field observation. For instance, could any amount of laboratory experimenting reveal the fact that *Sagitta bipunctata* is more abundant between 15 and 25 fathoms than at any other depth, or that it increases in abundance as the distance from the coast decreases?

In order to demonstrate the indispensability of a field method three aspects of the behavior of *S. bipunctata* are illustrated in some detail. First, the variation in abundance at all depths at different times of day is considered, showing how the species migrates vertically. Second, the fact that it accumulates in all depths in greatest numbers when the temperature lies between 13° and 16° C. is revealed. Third, data are presented showing that the species is more abundant, on the surface at least, when the salinity lies between 33.55 and 33.70.

Finally, the question of the interpretation of the results is discussed. Attention is called to the fact that an adequate interpretation necessitates recourse to the laboratory method. Obviously the field method can not, except by interference, ascertain the nature of response involved, *i. e.*, as to whether the demonstrated relations are due to a tropism, a taxis, a metabolic reaction, or to a direct physical effect of changes in viscosity and a specific gravity.

The Influence of Chance on the Number of Organisms Collected in Plankton Nets: GEORGE F. MCEWEN, Scripps Institute for Biological Research, La Jolla, California.

Measurements of a number of hydrographic elements and the corresponding abundance, or number of a species per unit volume of water in the ocean supply the data for determining the way in which the distribution of the species is related to these elements.

Practically, the distribution of the smaller organisms must be inferred from the number of each species collected per haul made with a plankton net. A plankton net filters rather variable fraction of the water that would pass through the net rim, if unobstructed; also the estimate of the distance hauled is usually subject to accidental errors of importance.

Grouping values of the abundance thus obtained with respect to each of a series of magnitudes of one of the environmental elements exhibits in tabular form the relation of the distribution to that element and the others linked with it. The errors in estimating the abundance arising from the use of a plankton net, the variability of the elements other than the one in question, and the fact that only a relatively small sample of the total population is examined have an important accidental influence on the character of the relation.

Illustrations are given of a method of testing the significance of the difference between two values of the abundance, which depends upon the probability that a difference in the same direction would arise by chance if the number of hauls were indefinitely increased. A plan is briefly outlined for eliminating the effects of all but one of the elements and testing the significance of the relation indicated by the corrected values of the abundance. The same methods are also applicable to statistical treatment of other kinds of quantitative data.

The Boring Mollusca of the Pacific Coast: MRS. IDA S. OLDROYD, Long Beach, California.

The Life History of the Pacific Herring: C. McLEAN FRASER.

The Pacific herring appear in large schools all along the Pacific coast from California to Alaska. The average weight of those caught in purse seines is about 3.6 oz. and the length 8 inches, not including caudal finrays. They wander about in search of food, which consists mainly of copepods. There is but one spawning season in one locality. Near the biological station, Nanaimo, this is in February and March. Spawning takes place in shallow water, but this may be incidental to the requirement of barnacle larvæ for food at that time. Both females and males rub against the sea weed while spawning. The spawn adheres, hatches out in 14 or 16 days and the yolk lasts another six days. First spawning takes place at the age of three or four years. Most herring caught are from four to eight years; some were found ten years old. The scale increases in size in approximately the same ratio as the other parts of the body and the different year growths are marked off by winter checks or rings. Those who have calculated the growth of the fish in each year from the rate of growth of the scales have failed to take into account that the scale does not start to grow when the fish does. The herring is 3.5 cm. long before the appearance of the scale. This should be taken into consideration when the length of the fish is divided according to the divisions of the scale as shown by winter checks.

The Nuclear Phenomena in Paramecium: R. T. YOUNG, University of North Dakota.

During the San Francisco meetings on Thursday, August 5, of the American Association for the Advancement of Science, there was formed a Pacific Branch of the American Society of Zoologists. The officers elected at this meeting were:

President, V. L. Kellogg, Stanford University, Palo Alto, California.

Vice-president, R. M. Yerkes, Santa Barbara, California.

Secretary and Treasurer, Joseph Grinnell, University of California, Berkeley, California.

Executive Committee, C. O. Esterly, Occidental College, Los Angeles, California; Barton W. Evermann, California Academy of Science, San Francisco, California; Charles L. Edwards, Los Angeles, California; J. Frank Daniel, University of California, Berkeley, California; Harold Heath, Stanford University, Palo Alto, California.

On Thursday, August 5, there was formed a Pacific Coast Branch of the American Society of Naturalists with the following organization:

President, Barton W. Evermann, California Academy of Sciences, San Francisco, California.

Vice-president, John F. Bovard, University of Oregon, Eugene, Oregon.

Secretary, Ellis Leroy Michael, Scripps Institute for Biological Research, La Jolla, California.

Treasurer, L. L. Burlingame, Stanford University, Palo Alto, California.

Executive Committee, Trevor Kincaid, University of Washington, Seattle, Wash.; Harry B. Torrey, Reed College, Portland, Oregon; Frank M. McFarland, Stanford University, Palo Alto, California.

The society will take the place of the local biological societies of the Pacific coast.

The Biological Society of the Pacific met at the Hotel Sutter, San Francisco, August 4, for their annual meeting. The address of the evening was given by Dr. Harry Beal Torrey, of Reed College, on "Research and the Elementary Student of Science." At this meeting the Biological Society voted to drop its organization in favor of the newly organized Pacific Branch of the American Society of Naturalists.

H. V. NEAL,
Secretary

SCIENCE

FRIDAY, NOVEMBER 12, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE HUMAN SIGNIFICANCE OF MATHEMATICS[1]

Homo sum; humani nil a me alienum puto.—*Terence.*

THE subject of this address is not of my choosing. It came to me by assignment. I may, therefore, be allowed to say that it is in my judgment ideally suited to the occasion. This meeting is held here upon this beautiful coast because of the presence of an international exposition, and we are thus invited to a befitting largeness and liberality of spirit. An international exposition properly may and necessarily will admit many things of a character too technical to be intelligible to any one but the expert and the specialist. Such things, however, are only incidental—contributory, indeed, yet incidental—to pursuit of the principal aim, which is, I believe, or ought to be, the representation of human things as human—an exhibition and interpretation of industries, institutions, sciences and arts, not primarily in their accidental or particular character as illustrating individuals or classes or specific localities or times, but primarily in their essential and universal character as representative of man. A world-exposition will, therefore, as far as practicable, avoid placing in the forefront matters so abstruse as to be fit for the contemplation and understanding of none but specialists; it will, as a whole, and in all its principal parts, address itself to the general intelligence; for it aims at being, for the multitudes of men and

[1] An address delivered August 3, 1915, Berkeley, Calif., at a joint meeting of the American Mathematical Society, the American Astronomical Society, and Section A of the American Association for the Advancement of Science.

women who avail themselves of its exhibitions and lessons, an exposition of humanity: an exposition, no doubt, of the activities and aspirations and prowess of individual men and women, but of men and women, not in their capacity as individuals, but as representatives of humankind. Individual achievements are not the object, they are the means, of the exposition. The object is humanity.

What is the human significance—what is the significance for humanity—of "the mother of the sciences"? And how may the matter be best set forth, not for the special advantage of professional mathematicians, for I shall take the liberty of having these but little in mind, but for the advantage and understanding of educated men and women in general? I am unable to imagine a more difficult undertaking, so technical, especially in its language, and so immense is the subject. It is clear that the task is far beyond the resources of an hour's discourse, and so it is necessary to restrict and select. This being the case, what is it best to choose? The material is superabundant. What part of it or aspect of it is most available for the end in view? "In abundant matter to speak a little with elegance," says Pindar, "is a thing for the wise to listen to." It is not, however, a question of elegance. It is a question of emphasis, of clarity, of effectiveness. What shall be our major theme?

Shall it be the history of the subject? Shall it be the modern developments of mathematics, its present status and its future outlook? Shall it be the utilities of the science, its so-called applications, its service in practical affairs, in engineering and in what it is customary to call the sciences of nature? Shall it be the logical foundations of mathematics, its basic principles, its inner nature, its characteristic processes and structure, the differences and similitudes that come to light in comparing it with other forms of scientific and philosophic activity? Shall it be the bearings of the science as distinguished from its applications—the bearings of it as a spiritual enterprise upon the higher concerns of man as man? It might be any one of these things. They are all of them great and inspiring themes.

It is easy to understand that a historian would choose the first. The history of mathematics is indeed impressive, but is it not too long and too technical? And is it not already accessible in a large published literature of its own? I grant, the historian would say, that its history is long, for in respect of antiquity mathematics is a rival of art, surpassing nearly all branches of science and by none of them surpassed. I grant that, for laymen, the history is technical, frightfully technical, requiring interpretation in the interest of general intelligence. I grant, too, that the history owns a large literature, but this, the historian would say, is not designed for the general reader, however intelligent, the numerous minor works, no less than the major ones, including that culminating monumental work of Moritz Cantor, being, all of them, addressed to specialists and intelligible to them alone. And yet it would be possible to tell in one hour, not indeed the history of mathematics, but a true story of it that would be intelligible to all and would show its human significance to be profound, manifold and even romantic. It would be possible to show historically that this science, which now carries its head so high in the tenuous atmosphere of pure abstractions, has always kept its feet upon the solid earth; it would be possible to show that it owns indeed a lowly origin, in the familiar needs of common life, in the homely necessities of counting herds and measuring lands; it would be possible to

show that, notwithstanding its birth in the concrete things of sense and raw reality, it yet so appealed to sheer intellect—and we must not forget that creative intellect is the human faculty par excellence—it so appealed to this distinctive and disinterested faculty of man that, long before the science rose to the level of a fine art in the great days of Euclid and Archimedes, Plato in the wisdom of his maturer years judged it essential to the education of freemen because, said he, there is in it a necessary something against which even God can not contend and without which neither gods nor demi-gods can wisely govern mankind; it would be possible, our historian could say, to show historically to educated laymen that, even prior to the inventions of analytical geometry and the infinitesimal calculus, mathematics had played an indispensable rôle in the "Two New Sciences" of physics and mechanics in which Galileo laid the foundations of our modern knowledge of nature; it would be possible to show not only that the analytical geometry of Descartes and Fermat and the calculus of Leibnitz and Newton have been and are essential to our still advancing conquest of the sea, but that it is owing to the power of these instruments that the genius of such as Newton, Laplace and Lagrange has been enabled to create for us a new earth and a new heavens compared with which the Mosaic cosmogony or the sublimest creation of the Greek imagination is but "as a cabinet of brilliants, or rather a little jewelled cup found in the ocean or the wilderness"; it would be possible to show historically that, just because the pursuit of mathematical truth has been for the most part disinterested—led, that is, by wonder, as Aristotle says, and sustained by the love of beauty with the joy of discovery—it would be possible to show that, just because of the disinterestedness of mathematical research, this science has been so well prepared to meet everywhere and always, as they have arisen, the mathematical exigencies of natural science and engineering; above all, it would be feasible to show historically that to the same disinterestedness of motive operating through the centuries we owe the upbuilding of a body of pure doctrine so towering to-day and vast that no man, even though he have the "Andean intellect" of a Poincaré, can embrace it all. This much, I believe, and perhaps more, touching the human significance of mathematics, a historian of the science might reasonably hope to demonstrate in one hour.

More difficult, far more difficult, I think, would be the task of a pure mathematician who aimed at an equivalent result by expounding, or rather by delineating, for he could not in one hour so much as begin to expound, the modern developments of the subject. Could he contrive even to delineate them in a way to reveal their relation to what is essentially humane? Do but consider for a moment the nature of such an enterprise. Mathematics may be legitimately pursued for its own sake or for the sake of its applications or with a view to understanding its logical foundations and internal structure or in the interest of magnanimity or for the sake of its bearings upon the supreme concerns of man as man or from two or more of these motives combined. Our supposed delineator is actuated by the first of them: his interest in mathematics is an interest in mathematics for the sake of mathematics; for him the science is simply a large and growing body of logical consistencies or compatibilities; he derives his inspiration from the muse of intellectual harmony; he is a pure mathematician. He knows that pure mathematics is a house of many chambers; he knows that its foundations lie far beneath

the level of common thought; and that the superstructure, quickly transcending the power of imagination to follow it, ascends higher and higher, ever keeping open to the sky; he knows that the manifold chambers—each of them a mansion in itself—are all of them connected in wondrous ways, together constituting a fit laboratory and dwelling for the spirit of men of genius. He has assumed the task of presenting a vision of it that shall be worthy of a world-exposition. Can he keep the obligation? He wishes to show that the life and work of pure mathematicians are human life and work: he desires to show that these toilers and dwellers in the chambers of pure thought are representative men. He would exhibit the many-chambered house to the thronging multitudes of his fellow men and women; he would lead them into it; he would conduct them from chamber to chamber by the curiously winding corridors, passing now downward, now upward, by delicate passage-ways and subtle stairs; he would show them that the wondrous castle is not a dead or static affair like a structure of marble or steel, but a living architecture, a living mansion of life, human as their own; he would show them the mathetic spirit at work, how it is ever weaving, tirelessly weaving, fabrics of beauty, finer than gossamer yet stronger than cables of steel; he would show them how it is ever enlarging its habitation, deepening its foundations, expanding more and more and elevating the superstructure; and, what is even more amazing, how it perpetually performs the curious miracle of permanence combined with change, transforming, that is, the older portions of the edifice without destroying it, for the structure is eternal: in a word, he would show them a vision of the whole, and he would do it in a way to make them perceive and feel that, in thus beholding there a partial and progressive attainment of the higher ideals of man, they were but gazing upon a partial and progressive realization of their own appetitions and dreams.

That is what he *would* do. But how? *Mengenlehre, Zahlenlehre,* algebras of many kinds, countless geometries of countless infinite spaces, function theories, transformations, invariants, groups and the rest—how can these with all their structural finesse, with their heights and depths and limitless ramifications, with their labyrinthine and interlocking modern developments—I will not say how can they be presented in the measure and scale of a great exposition—but how is it possible in one hour to give laymen even a glimpse of the endless array? Nothing could be more extravagant or more absurd than such an undertaking. Compared with it, the American traveler's hope of being able to see Rome in a single forenoon was a most reasonable expectation. But it is worth while trying to realize how stupendous the absurdity is.

It is evident that our would-be delineator must compromise. He can not expound, he can not exhibit, he can not even delineate the doctrines whose human worth he would thus disclose to his fellow men and women. The fault is neither his nor theirs. It must be imputed to the nature of things. But he need not, therefore, despair and he need not surrender. The method he has proposed—the method of exposition—that indeed he must abandon as hopeless, but not his aim. He is addressing men and women who are no doubt without his special knowledge and his special discipline, as he in his turn is without theirs, but who are yet essentially like himself. He would have them as fellows and comrades persuaded of the dignity of his *Fach:* he would have them feel that it is also theirs; he would

have them convinced that mathematics stands for an immense body of human achievements, for a diversified continent of pure doctrine, for a discovered world of intellectual harmonies. He can not *show* it to them as a painter displays a canvas or as an architect presents a cathedral. He can not give them an immediate vision of it, but he can give them intimations; by appealing to their *fantasie* and, through analogy with what they know, to their understanding, not only can he convince them that his world exists, but he can give them an intuitive apprehension of its living presence and its meaning for humankind. This is possible because, like him, they, too, are idealists, dreamers and poets—such essentially are all men and women. His auditors or his readers have all had *some* experience of ideas and of truth, they have all had inklings of more beyond, they have all been visited and quickened by a sense of the limitless possibilities of further knowledge in every direction, they have all dreamed of the perfect and have felt its lure. They are thus aware that the small implies the large; having seen hills, they can believe in mountains; they know that Euripides, Shakespeare, Dante, Goethe, are but fulfillments of prophecies heard in peasant tales and songs; they know that the symphonies of Beethoven or the dramas of Wagner are harbingered in the melodies and the sighs of those who garner grain and in their hearts respond to the music of the winds or the "solemn anthems of the sea"; they sense the secret by which the astronomy of Newton and Laplace is foretokened in the shepherd's watching of the stars; and knowing thus this plain spiritual law of progressiveness and implication, they are prepared to grasp the truth that modern mathematics, though they do not understand it, is, like the other great things, but a sublime fulfillment, the realization of prophecies involved in what they themselves, in common with other educated folk, know of the rudiments of the science. Indeed, they would marvel if upon reflection it did not seem to be so. Our pure mathematician in speaking to his fellow men and women of his science will have no difficulty in persuading them that he is speaking of a subject immense and eternal. As born idealists they have intimations of their own—the evidence of intuition, if you please—or a kind of insight resembling that of the mystic—that in the world of mind there must be something deeper and higher, stabler and more significant, than the pitiful ideas in life's routine and the familiar vocations of men. They are thus prepared to believe, before they are told, that behind the veil there exists a universum of exact thought, an everlasting cosmos of ordered ideas, a stable world of concatenated truth. In their study of the elements, in school or college, they may have caught a shimmer of it or, in rare moments of illumination, even a gleam. Of the existence, the reality, the actuality, of our pure mathematician's world they will have no doubt, and they will have no doubt of its grandeur. They may even, in a vague way, magnify it overmuch, feeling that it is, in some wise, *more* than human, significant only for the rarely gifted spirit that dwells, like a star, apart. The pure mathematician's difficulty lies in showing, in *his* way, that such is not the case. For he does not wish to adduce utilities and applications. He is well aware of these. He knows that if he "would tell them they are more in number than the sands." Neither does he despise them as of little moment. On the contrary, he values them as precious. But he wishes to do his subject and his auditors the honor of speaking from a higher level: he desires to vindicate the worth of mathematics on the ground of its

sheer ideality, on the ground of its intellectual harmony, on the ground of its beauty, "free from the gorgeous trappings" of sense, pure, austere, supreme. To do this, which ought, it seems, to be easy, experience has shown to be exceedingly difficult. For the multitude of men and women, even the educated multitude, are wont to cry,

> Such knowledge is too wonderful for me,
> It is too high, I can not attain unto it,

thus meaning to imply, What, then, or where is its human significance? Their voice is heard in the challenge once put to me by the brilliant author of "East London Visions." What, said he, can be the human significance of "this majestic intellectual cosmos of yours, towering up like a million-lustred iceberg into the arctic night," seeing that, among mankind, none is permitted to behold its more resplendent wonders save the mathematician alone? What response will our pure mathematician make to this challenge? Make, I mean, if he be not a wholly naïve devotee of his science and so have failed to reflect upon the deeper grounds of its justification. He may say, for one thing, what Professor Klein said on a similar occasion:

> Apart from the fact that pure mathematics can not be supplanted by anything else as a means for developing the purely logical faculties of the mind, there must be considered here, as elsewhere, the necessity of the presence of a few individuals in each country developed in far higher degree than the rest, for the purpose of keeping up and gradually raising the *general* standard. Even a slight raising of the general level can be accomplished only when some few minds have progressed far ahead of the average.

That is doubtless a weighty consideration. But is it all or the best that may be said? It is just and important but it does not go far enough; it is not, I fear, very convincing; it is wanting in pungence and edge; it does not touch the central nerve of the challenge. Our pure mathematician must rally his sceptics with sharper considerations. He may say to them: You challenge the human significance of the higher developments of pure mathematics because they are inaccessible to all but a few, because their charm is esoteric, because their deeper beauty is hid from nearly all mankind. Does that consideration justify your challenge? You are individuals, but you are also members of a race. Have you as individuals no human interest nor human pride in the highest achievements of your race? Is nothing human, is nothing humane, except mediocrity and the commonplace? Was Phidias or Michel Angelo less human than the carver and painter of a totem-pole? Was Euclid or Gauss or Poincaré less representative of man than the countless millions for whom mathematics has meant only the arithmetic of the market place or the rude geometry of the carpenter? Does the quality of humanity in human thoughts and deeds decrease as they ascend towards the peaks of achievement, and increase in proportion as they become vulgar, attaining an upper limit in the beasts? Do you not know that precisely the reverse is true? Do you not count aspiration humane? Do you not see that it is not the common things that every one may reach, but excellences high-dwelling among the rocks—do you not know that, in respect of human worth, these things, which but few can attain, are second only to the supreme ideals attainable by none?

How very different and how very much easier the task of one who sought to vindicate the human significance of mathematics on the ground of its applications! In respect of temperamental interest, of attitude and outlook, the difference between the pure and the applied mathematician is profound. It is—if we may liken spiritual

things to things of sense—much like the difference between one who greets a new-born day because of its glory and one who regards it as a time for doing chores and values its light only as showing the way. For the former, mathematics is justified by its supreme beauty; for the latter, by its manifold use. But are the two kinds of value essentially incompatible? They are certainly not. The difference is essentially a difference of authority—a difference, that is, of worth, of elevation, of excellence. The pure mathematician and the applied mathematician sometimes may, indeed they not infrequently do, dwell together harmoniously in a single personality. If our spokesman be such a one—and I will not suppose the shame of having the utilities of the science represented on such an occasion by one incapable of regarding it as anything but a tool, for that would be disgraceful—if, then, our spokesman be such a one as I have supposed, he might properly begin as follows: In speaking to you of the applications of mathematics I would not have you suppose, ladies and gentlemen, that I am thus presenting the *highest* claims of the science to your regard; for its highest justification is the charm of its immanent beauty; I do not mean, he will say, the beauty of appearances—the fleeting beauties of sense, though these, too, are precious—even the outer garment, the changeful robe, of reality is a lovely thing; I mean the eternal beauty of the world of pure thought; I mean intellectual beauty; in mathematics this nearly attains perfection; and "intellectual beauty is self-sufficing"; uses, on the other hand, are not; they wear an aspect of apology; uses resemble excuses, they savor a little of a plea in mitigation. Do you ask: Why, then, plead them? Because, he will say, many good people have a natural incapacity to appreciate anything else; because, also, many of the applications, especially the higher ones, are themselves matters of exceeding beauty; and especially because I wish to show, not only that use and beauty are compatible forms of worth, but that the more mathematics has been cultivated for the sake of its inner charm, the fitter has it become for external service.

Having thus at the outset put himself in proper light and given his auditors a scholar's warning against what would else, he fears, foster a disproportionment of values, what will he go on to signalize among the utilities of a science whose primary allegiance to logical rectitude allies it to art, and which only incidentally and secondarily shapes itself to the ends of instrumental service? He knows that the applications of mathematics, if one will but trace them out in their multifarious ramifications, are as many-sided as the industries and as manifold as the sciences of men, penetrating everywhere throughout the full round of life. What will he select? He will not dwell long upon its homely uses in the rude computations and mensurations of counting-house and shop and factory and field, for this indispensable yet humble manner of world-wide and perpetual service is known of all men and women. He will quickly pass to higher considerations—to navigation, to the designing of ships, to the surveying of lands and seas, and the charting of the world, to the construction of reservoirs and aqueducts, canals, tunnels and railroads, to the modern miracles of the marine cable, the telegraph, the telephone, to the multiform achievements of every manner of modern engineering, civil, mechanical, mining, electrical, by which, through the advancing conquest of land and sea and air and space and time, the conveniences and the prowess of man have been multiplied a billionfold. It need not

be said that not all this has been done by mathematics alone. Far from it. It is, of course, the joint achievement of many sciences and arts, but—and just this is the point—the contributions of mathematics to the great work, direct and indirect, have been indispensable. And it will require no great skill in our speaker to show to his audience, if it have a little imagination, that, as I have said elsewhere, if all these mathematical contributions were by some strange spiritual cataclysm to be suddenly withdrawn, the life and body of industry and commerce would suddenly collapse as by a paralytic stroke, the now splendid outer tokens of material civilization would quickly perish, and the face of our planet would at once assume the aspect of a ruined and bankrupt world. For such is the amazing utility, such the wealth of by-products, if you please, that come from a science and art that owes its life, its continuity and its power to man's love of intellectual harmony and pleads its inner charm as its sole appropriate justification. Indeed it appears—contrary to popular belief—that in our world there is nothing else quite so practical as the inspiration of a muse.

But this is not all nor nearly all to which our applied mathematician will wish to invite attention. It is only the beginning of it. Even if he does not allude to the quiet service continuously and everywhere rendered by mathematics in its rôle as a norm or standard or ideal in every field of thought whether exact or inexact, he will yet desire to instance forms and modes of application compared with which those we have mentioned, splendid and impressive as they are, are meager and mean. For those we have mentioned are but the more obvious applications—those, namely, that continually announce themselves to our senses everywhere in the affairs, both great and small, of the workaday world. But the really great applications of mathematics—those which, rightly understood, best of all demonstrate the human significance of the science—are not thus obvious; they do not, like the others, proclaim themselves in the form of visible facilities and visible expedients everywhere in the offices, the shops, and the highways of commerce and industry; they are, on the contrary, almost as abstract and esoteric as mathematics itself, for they are the uses and applications of this science in other sciences, especially in astronomy, in mechanics and in physics, but also and increasingly in the newer sciences of chemistry, geology, mineralogy, botany, zoology, economics, statistics and even psychology, not to mention the great science and art of architecture. In the matter of exhibiting the endless and intricate applications of mathematics to the natural sciences, applications ranging from the plainest facts of crystallography to the faint bearings of the kinetic theory of gases upon the constitution of the Milky Way, our speaker's task is quite as hopeless as we found the *pure* mathematician's to be; and he, too, will have to compromise; he will have to request his auditors to acquaint themselves at their leisure with the available literature of the subject and especially to read attentively the great work of John Theodore Merz dealing with the "History of European Thought in the Nineteenth Century," where they will find, in a form fit for the general reader, how central has been the rôle of mathematics in all the principal attempts of natural science to find a cosmos in the seeming chaos of the natural world. Another many-sided work that in this connection he may wish to commend as being in large part intelligible to men and women of general education and catholic mind is Enriques's "Problems of Science."

I turn now for a moment to the prospects of one who might choose to devote the hour to an exposition or an indication of modern developments in what it is customary to call the foundations of mathematics—to a characterization, that is, and estimate of that far-reaching and still advancing critical movement which has to do with the relations of the science, philosophically considered, to the sciences of logic and methodology. What can he say on this great theme that will be intelligible and edifying to the multitudes of men and women who, though mathematically inexpert, yet have a genuine humane curiosity respecting even the profounder and subtler life and achievements of science? He can point out that mathematics, like all the other sciences, like the arts too, for that matter, and like philosophy, originates in the refining process of reflection upon the crude data of common sense; he can point out that this process has gradually yielded from out the raw material and still continues to yield more and more ideas of approximate perfection in the respects of precision and form; he can point out that such ideas, thus disentangled and trimmed of their native vagueness and indetermination, disclose their mutual relationships and so become amenable to the concatenative processes of logic; and he can point out that these polished ideas with their mutual relationships become the bases or the content of various branches of mathematics, which thus tower above common sense and appear to grow out of it and to stand upon it like trees or forests upon the earth. He will point out, however, that this appearance, like most other obvious appearances, is deceiving; he will, that is, point out that these upward-growing sciences or branches of science are found, in the light of further reflection, to be downward-growing as well, pushing their roots deeper and deeper into a dark soil far beneath the ground of evident common sense; indeed, he will show that common sense is thus, in its relation to mathematics, but as a sense-litten mist enveloping only the mid-portion of the stately structure, which, like a towering mountain, at once ascends into the limpid ether far above the shining cloud and rests upon a base of subterranean rock far below; he will point out that, accordingly, mathematicians, in respect of temperamental interest, fall into two classes—the class of those who cultivate the upward-growing of the science, working thus in the upper regions of clearer light, and the class of those who devote themselves to exploring the deep-plunging roots of the science; and it is, he will say, to the critical activity of the latter class—the logicians and philosophers of mathematics—that we owe the discovery of what we are wont to call the foundations of mathematics—the great discovery, that is, of an immense mathematical *sub*-structure, which penetrates far beneath the stratum of common sense and of which many of even the greatest mathematicians of former times were not aware. But whilst such foundational research is in the main a modern phenomenon, it is by no means exclusively such; and to protect his auditors against a false perspective in this regard and the peril of an overweening pride in the achievements of their own time, our speaker may recommend to them the perusal of Thomas L. Heath's superb edition of Euclid's "Elements" where, especially in the first volume, they will be much edified to find, in the rich abundance of critical citation and commentary which the translator has there brought together, that the refined and elaborate logico-mathematical researches of our own time have been only a deepening and widening of the keen mathematical criticism of a few

centuries immediately preceding and following the great date of Euclid. Indeed but for that general declension of Greek spirit which Professor Gilbert Murray in his "Four Stages in Greek Religion" has happily characterized as "the failure of nerve," what we know as the modern critical movement in mathematics might well have come to its present culmination, so far at least as pure geometry is concerned, fifteen hundred or more years ago. It is a pity that the deeper and stabler things of science and the profounder spirit of man can not be here disclosed in a manner commensurate with the great exposition, surrounding us, of the manifold practical arts and industries of the world. It is a pity there is no means by which our speaker might, in a manner befitting the subject and the occasion, exhibit intelligibly to his fellow men and women the ways and results of the last hundred years of research into the groundwork of mathematical science and therewith the highly important modern developments in logic and the theory of knowledge. How astonished the beholders would be, how delighted, too, and proud to belong to a race capable of such patience and toil, of such disinterested devotion, of such intellectual finesse and depth of penetration. I can think of no other spectacle quite so impressive as the inner vision of all the manifold branches of rigorous thought seen to constitute one immense structure of autonomous doctrine reposing upon the spiritual basis of a few select ideas and, superior to the fading beauties of time and sense, shining there like a celestial city, in "the white radiance of eternity." That is the vision of mathematics that a student of its philosophy would, were it possible, present to his fellow men and women.

In view of the foregoing considerations it evidently is, I think, in the nature of the case impossible to give an adequate sense of the human worth of mathematics if one choose to devote the hour to any one of the great aspects of it with which we have been thus far concerned. Neither the history of the subject nor its present estate nor its applications nor its logical foundations—no one of these themes lends itself well to the purpose of such an exposition, and still less do two or more of them combined. Even if such were not the case I should yet feel bound to pursue another course; for I have been long persuaded that, in respect of its human significance, mathematics invites to a point of view which, unless I am mistaken, has not been taken and held in former attempts at appreciation. I have already alluded to bearings of mathematics as distinguished from applications. It is with its bearings that I wish to deal. I mean its bearings upon the higher concerns of man as man—those interests, namely, which have impelled him to seek, over and above the needs of raiment and shelter and food, some inner adjustment of life to the poignant limitations of life in our world and which have thus drawn him to manifold forms of wisdom, not only to mathematics and natural sciences, but also to literature and philosophy, to religion and art, and theories of righteousness. What is the rôle of mathematics in this perpetual endeavor of the human spirit everywhere to win reconciliation of its dreams and aspirations with the baffling conditions and tragic facts of life and the world? What is its relation to the universal quest of man for some supreme and abiding good that shall assuage or annul the discords and tyrannies of time and limitation, withholding less and less, as time goes by, the freedom and the peace of an ideal harmony infinite and eternal?

In endeavoring to suggest, in the time remaining for this address, a partial answer

to that great question, in attempting, that is, to indicate the relations of mathematics to the supreme ideals of mankind, it will be necessary to seek a perspective point of view and to deal with large matters in a large way.

Of the countless variety of appetitions and aspirations that have given direction and aim to the energies of men and that, together with the constraining conditions of life in our world, have shaped the course and determined the issues of human history, it is doubtless not yet possible to attempt a confident and thoroughgoing classification according to the principle of relative dignity or that of relative strength. If, however, we ask whether, in the great throng of passional determinants of human thought and life, there is one supreme passion, one that in varying degrees of consciousness controls the rest, unifying the spiritual enterprises of our race in directing and converging them all upon a single sovereign aim, the answer, I believe, can not be doubtful: the activities and desires of mankind are indeed subject to such imperial direction and control. And if now we ask what the sovereign passion is, again the answer can hardly admit of question or doubt. In order to see even *a priori* what the answer must be, we have only to imagine a race of beings endowed with our human craving for stability, for freedom, and for perpetuity of life and its fleeting goods, we have only to fancy such a race flung, without equipment of knowledge or strength, into the depths of a treacherous universe of matter and force where they are tossed, buffeted and torn by the tumultuous onward-rushing flood of the cosmic stream, originating they know not whence and flowing they know not why nor whither, we have, I say, only to imagine *this*, sympathetically, which ought to be easy for us as men, and then to ask ourselves what would *naturally* be the controlling passion and dominant enterprise of such a race—unless, indeed, we suppose it to become strangely enamored of distress or to be driven by despair to self-extinction. We humans require no Gotama nor Heracleitus to tell us that man's lot is cast in a world where naught abides. The universal impermanence of things, the inevitableness of decay, the mocking frustration of deepest yearnings and fondest dreams, all this has been keenly realized wherever men and women have had seeing eyes or been even a little touched with the malady of meditation, and everywhere in the literature of power is heard the cry of the mournful truth. "The life of man," said the Spirit of the Ocean, "passes by like a galloping horse, changing at every turn, at every hour."

> "Great treasure halls hath Zeus in heaven,
> From whence to man strange dooms be given,
> Past hope or fear."

Such is the universal note. Whether we glance at the question in a measure *a priori*, as above, or look into the cravings of our own hearts, or survey the history of human emotion and thought, we shall find, I think, in each and all these ways, that human life owns the supremacy of one desire: it is the passion for emancipation, for release from life's limitations and the tyranny of change: it is our human passion for some ageless form of reality, some everlasting vantage-ground or rock to stand upon, some haven of refuge from the all-devouring transformations of the weltering sea. And so it is that our human aims, aspirations, and toils thus find their highest unity—their only intelligible unity—in the Spirit's quest of a stable world, in its endless search for some mode or form of reality that is at once infinite, changeless, eternal.

Does some one say: This may be granted,

but what is the point of it all? It is obviously true enough but what, pray, can be its bearing upon the matter in hand? What light does it throw upon the human significance of mathematics? The question is timely and just. The answer, which will grow in fullness and clarity as we proceed, may be at once begun.

How long our human ancestors, in remote ages, may have groped, as some of their descendants even now grope, among the things of *sense*, in the hope of finding *there* the desiderated good, we do not know—past time is long and the evolution of wisdom has been slow. We do know that, long before the beginnings of recorded history, superior men—advanced representatives of their kind—must have learned that the deliverance sought was not to be found among the objects of the *mobile* world, and so the spirit's quest passed from thence; passed from the realm of perception and sense to the realm of concept and reason: thought ceased, that is, to be merely the unconscious means of pursuit and became itself the quarry—mind had discovered mind; and there, in the realm of ideas, in the realm of spirit proper, in the world of reason or thought, the great search—far outrunning historic time—has been endlessly carried on, with varying fortunes, indeed, but without despair or breach of continuity, meanwhile multiplying its resources and assuming gradually, as the years and centuries have passed, the characters and forms of what we know today as philosophy and science and art. I have mentioned the passing of the quest from the realm of sense to the realm of conception: a most notable transition in the career of mind and especially significant for the view I am aiming to sketch. For thought, in thus becoming a conscious subject or object of thought, then began its destined course in reason: in ceasing to be merely an unconscious means of pursuit and becoming itself the quarry, it definitely entered upon the arduous way that leads to the goal of rigor. And so it is evident that the way in question is not a private way; it does not belong exclusively to mathematics; it is public property; it is the highway of conceptual research. For it is a mistake to imagine that mathematics, in virtue of its reputed exactitude, is an insulated science, dwelling apart in isolation from other forms and modes of conceptual activity. It would be such, were its rigor absolute; for between a perfection and any approximation thereto, however close, there always remains an infinitude of steps. But the rigor of mathematics is not absolute—absolute rigor is an ideal, to be, like other ideals, aspired unto, forever approached, but never quite attained, for such attainment would mean that every possibility of error or indetermination, however slight, had been eliminated from idea, from symbol, and from argumentation. We know, however, that such elimination can never be complete, unless indeed the human mind shall one day lose its insatiable faculty for doubting. What, then, *is* the distinction of mathematics on the score of exactitude? Its distinction lies, not in the attainment of rigor absolute, but partly in its exceptional devotion thereto and especially in the advancement it has made along the endless path that leads towards that perfection. But, as I have already said, it must not be thought that mathematics is the sole traveler upon the way. It is important to see clearly that it is far from being thus a solitary enterprise. First, however, let us adjust our imagery to a better correspondence with the facts. I have spoken of *the* path. We know, however, that the paths are many, as many as the varieties of conceptual subject-matter, all of them converging towards the same high goal. We

see them originate here, there and yonder in the soil and haze of common thought; we see how indistinct they are at first—how ill-defined; we observe how they improve in that regard as the ideas involved grow clearer and clearer, more and more amenable to the use and governance of logic. At length, when thought, in its progress along any one of the many courses, has reached a high degree of refinement, precision and certitude, then and thereafter, but not before, we call it mathematical thought; it has undergone a long process of refining evolution and acquired at length the name of mathematics; it is not, however, the creature of its name; what is called mathematics has been long upon the way, owning at previous stages other designations—common sense, practical art perhaps, speculation, theology it may be, philosophy, natural science, or it may be for many a millenium no name at all. Is it, then, only a question of names? In a sense, yes: the ideal of thought is rigor; mathematics is the name that usage employs to designate, not attainment of the ideal, for it can not be attained, but its devoted pursuit and close approximation. But this is not the essence of the matter. The essence is that all thought, thought in all its stages, however rude, however refined, however named, owns the unity of being human: spiritual activities are one. Mathematics thus belongs to the great family of spiritual enterprises of man. These enterprises, all the members of the great family, however diverse in form, in modes of life, in methods of toil, in their progress along the way that leads towards logical rectitude, are alike children of one great passion. In genesis, in spirit and aspiration, in motive and aim, natural science, theology, philosophy, jurisprudence, religion and art are one with mathematics: they are all of them sprung from the human spirit's craving for invariant reality in a world of tragic change; they all of them aim at rescuing man from "the blind hurry of the universe from vanity to vanity": they seek cosmic stability—a world of abiding worth, where the broken promises of hope shall be healed and infinite aspiration shall cease to be mocked.

Such has been the universal and dominant aim and such are the cardinal forms that time has given its prosecution.

And now we must ask: What have been the fruits of the endless toil? What has the high emprize won? And what especially, have been the contributions of mathematics to the total gain? To recount the story of the spirit's quest for ageless forms of reality would be to tell afresh, from a new point of view, the history of human thought, so many and so diverse are the modes or aspects of being that men have found or fancied to be eternal. Edifying indeed would be the tale, but it is long, and the hour contracts. Even a meager delineation is hardly possible here. Yet we must not fail to glance at the endless array and to call, at least in part, the roll of major things. But where begin? Shall it be in theology? How memory responds to the magic word. "The past rises before us like a dream." As the long succession of the theological centuries passes by, what a marvelous pageant do they present of human ideals, contrivings and dreams, both rational and superrational. Alpha and Omega, the beginning and ending, which is, which was and which is to come; I Am That I Am; Father of lights with which is no variableness, neither shadow of turning; the bonitas, unitas, infinitas, immutabilitas of Deity; the undying principle of soul; the sublime hierarchy of immortal angels, terrific and precious, discoursed of by sages, commemorated by art, feared and loved by millions of men

and women and children: these things may suffice to remind us of the invariant forms of reality found or invented by theology in her age-long toil and passion to conquer the mutations of time by means of things eternal.

But theology's record is only an immense chapter of the vastly more inclusive annals of world-wide philosophic speculation running through the ages. If we turn to philosophy understood in the larger sense, if we ask what answers she has made in the long course of time to the question of what is eternal, so diverse and manifold are the voices heard across the centuries, from the East and from the West, that the combined response must needs seem to an unaccustomed ear like an infinite babel of tongues: the Confucian Way of Heaven; the mystic Tao, so much resembling fate, of Lao Tzu and Chuang Tzu; Buddhism's inexorable spiritual law of cause and effect and its everlasting extinction of individuality in Nirvana—the final blowing out of consciousness and character alike; Ahura Mazda, the holy One, of Zarathustra; Fate, especially in the Greek tragedies and Greek religion—the chain of causes in nature, "the compulsion in the way things grow," a fine thread running through the whole of existence and binding even the gods; the cosmic matter, or το απειρον of Anaximander; the cosmic order, the rhythm of events, the logos or reason or nous, of Heracleitus; the finite, space-filling sphere, or One, of the deep Parmenides; the four material and two psychic, six eternal, elements, of Empedocles; the infinitude of everlasting mind-moved simple substances of Anaxagoras; the infinite multitude and endless variety of invariant "seeds of things" of Leucippus, Democritus, Epicurus and Lucretius, together with their doctrines of absolute void and the conservations of mass and motion and infinite room or space; Plato's eternal world of pure ideas; the great Cosmic Year of a thousand thinkers, rolling in vast endlessly repeated cycles on the beginningless, endless course of time from eternity to eternity; the changeless thought-forms of Zeno, Gorgias and Aristotle; Leibnitz's indestructible, preestablished harmony; Spinoza's infinite unalterable substance; the Absolute of the Hegelian school; and so on and on far beyond the limits of practicable enumeration. This somewhat random partial list of things will serve to recall and to represent the enormous motley crowd of answers that the ages of philosophic speculation have made to the supreme inquiry of the human spirit: what is there that survives the mutations of time, abiding unchanged despite the whirling flux of life and the world?

And now, in the interest of further representing salient features in a large perspective view, let me next ask what contribution to the solution of the great problem has been made by jurisprudence. Jurisprudence is no doubt at once a branch of philosophy and a branch of science, but it has an interest, a direction and a character of its own. And for the sake of due emphasis it will be well worth while to remind ourselves specifically of the half-forgotten fact that, in its quest for justice and order among men, jurisprudence long ago found an answer to our oft-stated riddle of the world, an answer which, though but a partial one, yet satisfied the greatest thinkers for many centuries, and which, owing to the inborn supernalizing proclivity of the human mind, still exercises sway over the thought of the great majority of mankind. I allude to the conception of *jus naturale* or *lex naturæ*, the doctrine that in the order of Nature there somehow exists a perfect, invariant, uni-

versally and eternally valid system or prototype of law over and above the imperfect laws and changeful polities of men—a conception and doctrine long familiar in the juristic thought of antiquity, dominating, for example, the Antigone of Sophocles, penetrating the Republic and the Laws of Plato, proclaimed by Demosthenes in the Oration on the Crown, becoming, largely through the Republic and the Laws of Cicero, the crowning conception of the imperial jurisprudence of Rome, and still holding sway, as I have said, except in the case of our doubting Thomases of the law, who virtually deny our world the existence of any perfection whatever because they can not, so to speak, feel it with the hand, as if they did not know that to suppose an ideal to be *thus* realized would be a flat contradiction in terms.

If we turn for a moment to art and enquire what has been *her* relation to the poignant riddle, shall we not thus be going too far afield? The answer is certainly no. *In æternitatem pingo,* said Zeuxis, the Greek painter. "The purpose of art," says John La Farge, "is commemoration." In these two sayings, one of them ancient, the other modern, we have, I think, the evident clue. They do but tell us that art, like the other great enterprises of man, springs from our spirit's coveting of worth that abides. Like theology, like philosophy, like jurisprudence, like natural science, too, as I mean to point out further, and like mathematics, art is born of the universal passion for the dignity of things eternal. Her quest, like theirs, has been a search for invariants, for goods that are everlasting. And what has she found? The answer is simple. "The idea of beauty in each species of being," said Joshua Reynolds, "is perfect, invariable, divine." We know that by a faculty of imaginative, mystical, idealizing discernment there is revealed to us, amid the fleeting beauties of Time, the immobile presence of eternal beauty, immutable archetype and source of the grace and loveliness beheld in the shifting scenes of the flowing world of sense. Such, I take it, is art's contribution to our human release from the tyranny of change and the law of death.

And now what should be said of science? Not so brief and far less simple would be the task of characterizing or even enumerating the many things that in the great drama of modern science have been assigned the rôle of invariant forms of reality or eternal modes of being. It would be necessary to mention first of all, as most imposing of all, our modern form of the ancient doctrine of fate. I mean the reigning conception of our universe as an infinite machine—a powerful conception that more and more fascinates scientific minds even to the point of obsession and according to which it should be possible, were knowledge sufficiently advanced, to formulate, in a system of differential equations, the whole of cosmic history from eternity to eternity in minutest detail, not even excluding a skeptic's doubt whether such formulation be theoretically possible nor excluding the conviction, which some minds have, that the doctrine, regarded as an *ultimate* creed, is an abominable libel against the character of a world where the felt freedom of the human spirit is not an illusion. It would be necessary to mention—as next perhaps in order of impressiveness—another doctrine that is, curiously enough, vividly reminiscent of old-time fate. I allude this time to the doctrine of heredity, a tremendous conception, in accordance with which—as Professor W. B. Smith has said in his recent powerful address on "Push or Pull?"—

"the remotest past reaches out its skeletal fingers and grapples both present and future in its iron grip." And there is the conservation of energy and that of mass—both of them, again, doctrines prefigured in the thought of ancient Greece—and numerous other so-called natural laws, simple and complex, familiar and unfamiliar, all posing as permanent forms of reality—as natural invariants under the infinite system of cosmic transformations—and thus together constituting the enlarging contribution of natural science towards the slow vindication of a world that has seemed capricious, lawless and impermanent.

Such, then, is a conspectus, suggested rather than portrayed, of the results which the great allies of mathematics, operating through the ages, have achieved in their passionate endeavor to transcend the tragic vicissitudes and limitations of life in an "ever-growing and perishing" universe and to win at length the freedom, the dignity and the peace of a stable world where order and harmony reign and spiritual goods endure. If we are to arrive at a really just or worthy sense of the human significance of mathematics, it is in relation with those great results of her sister enterprises that the achievements of this science must be appraised. Immense indeed and high is the task of criticism as thus conceived. How diverse and manifold the doctrines to be evaluated, what depths to be plumbed, what heights to be scaled, how various the relationships and dignities to be assigned their rightful place in the hierarchy of values. In the presence of such a task what can we think or say in the remaining moments of the hour? If we have succeeded in setting the problem in its proper light and in indicating the sole eminence from which the matter may be rightly viewed, we ought perhaps to be content with that as the issue of the hour, for it is worth while to sketch a worthy program of criticism even if time fails us to perform fully the task thus set. And yet I can not refrain from inviting you to imagine, before we close, a few at least of the things that one who essayed the great critique would submit to his auditors for mediation. And what do you imagine the guiding lines and major themes of his discourse would be?

I fancy he would say: The question before us, ladies and gentlemen, is not a question of weighing utilities nor of counting applications nor of measuring material gains; it is a question of human ideals together with the various means of pursuing them and the differing degrees of their approximation; we are occupied with a question of appreciation, with the problem of values. I am, he would say, addressing you as representatives of man, and in so doing, I am not regarding man as a mere practician, as a hewer of wood and drawer of water, as an animal content to serve the instincts for shelter and food and reproduction. I am contemplating him as a spiritual being, as a thinker, poet, dreamer, as a lover of knowledge and beauty and wisdom and the joy of harmony and light, responding to the lure of an ideal destiny, troubled by the mystery of a baffling world, conscious subject of tragedy, yearning for stable reality, for infinite freedom, for perpetuity and a thousand perfections of life. As representatives of such a being, you, he would say, and I, even if we be not ourselves producers of theology or philosophy or science or jurisprudence or art or mathematics, are nevertheless rightful inheritors of all this manifold wisdom of man. The question is: What is the inheritance worth? We are the heirs and we are to be the judges of the great responses that time has made to

the spiritual needs of humanity. What are the responses worth? What are their values, joint and several, absolute and relative? And what, especially, is the human worth of the response of mathematics? It is, he would say, not only our privilege, but, as educated individuals and especially as representatives of our race, it is our duty, to ponder the matter and reach, if we can, a right appraisement. For the proper study of mankind is man, and it is essential to remember that "*La vie de la science est la critique.*" I have, he would say, tried to make it clear that mathematics is not an isolated science. I have tried to show that it is not an antagonist, nor a rival, but is the comrade and ally of the other great forms of spiritual activity, all aiming at the same high end. I have reminded you of the principal answers made by these to the spiritual needs of man, and I do not, he would say, desire to underrate or belittle them. They are a precious inheritance. Many of them have not, indeed, stood the test of time; others will doubtless endure for aye; all of them, for a longer or shorter period, have softened the ways of life to millions of men and women. Neither do I desire, he would say, to exaggerate the contributions of mathematics to the spiritual weal of humanity. What I desire is a fair comparative estimate of its claims. "Truth is the beginning of every good thing, both to gods and men." I am asking you to compare, consider and judge for yourselves. The task is arduous and long.

There are, our critic would say, certain paramount considerations that every one in such an enterprise must weigh, and a few of them may, in the moments that remain, be passed in brief review. Consider, for example, our human craving for a world of stable reality. Where is it to be found? We know the answer of theology, of philosophy, of natural science and the rest. We know, too, the answer of literature and general thought:

> The cloud-capped towers, the gorgeous palaces,
> The solemn temples, the great globe itself,
> Yea, all which it inherit, shall dissolve,
> And, like the baseless fabric of this vision,
> Leave not a rock behind.

And now what, he would ask, is the answer of mathematics? The answer, he would have to say, is this: Transcending the flux of the sensuous universe, there exists a stable world of pure thought, a divinely ordered world of ideas, accessible to man, free from the mad dance of time, infinite and eternal.

Consider our human craving for freedom. Of freedom there are many kinds. Is it the freedom of limitless room, where our passion for outward expression, for externalization of thought, may attain its aim? It is to mathematics, our critic would say, that man is indebted for that priceless boon; for it is the cunning of this science that has at length contrived to release our long imprisoned thought from the old confines of our three-fold world of sense and opened to its wing the interminable skies of hyperspace. But if it be a more fundamental freedom that is meant, if it be freedom of thought proper—freedom, that is, for the creative activity of intellect—then again it is to mathematics that our faculties must look for the definition and a right estimate of their prerogatives and power. For, regarding this matter, we may indeed acquire elsewhere a suspicion or an inkling of the truth, but mathematics, and nothing else, is qualified to give us *knowledge* of the fact that our intellectual freedom is absolute save for a single limitation—the law of non-contradiction, the law of logical compatibility, the law of intellectual harmony—sole restriction imposed by "the nature of

things" or by logic or by the muses upon the creative activity of the human spirit.

Consider next, the critic might say, our human craving for a living sense of rapport and comradeship with a divine Being infinite and eternal. Except through the modern mathematical doctrine of infinity, there is, he would have to say, no rational way by which we may even approximate an understanding of the supernal attributes with which our faculty of idealization has clothed Deity—no way, except this, by which our human reason may gaze understandingly upon the downward-looking aspects of the overworld. But this is not all. I need not, he would say, remind you of the reverent saying attributed to Plato that "God is a geometrician." Who is so unfortunate as not to know something of the religious awe, the solace and the peace that come from cloistral contemplation of the purity and everlastingness of mathematical truth?

> Mighty is the charm of those abstractions to a mind beset with images and haunted by himself.

"More frequently," says Wordsworth, speaking of geometry,

> More frequently from the same source I drew
> A pleasure quiet and profound, a sense
> Of permanent and universal sway,
> And paramount belief; there, recognized
> A type, for finite natures, of the one
> Supreme Existence, the surpassing life
> Which to the boundaries of space and time,
> Of melancholy space and doleful time,
> Superior and incapable of change,
> Not touched by welterings of passion—is,
> And hath the name of God. Transcendent peace
> And silence did wait upon those thoughts
> That were a frequent comfort to my youth.

And so our spokesman, did time allow, might continue, inviting his auditors to consider the relations of mathematics to yet other great ideals of humanity—our human craving for rectitude of thought, for ideal justice, for dominion over the energies and ways of the material universe, for imperishable beauty, for the dignity and peace of intellectual harmony. We know that in all such cases the issue of the great critique would be the same, and it is needless to pursue the matter further. The light is clear enough. Mathematics is, in many ways, the most precious response that the human spirit has made to the call of the infinite and eternal. It is man's best revelation of the "Deep Base of the World."

CASSIUS J. KEYSER

COLUMBIA UNIVERSITY

THE NATIONAL ACADEMY OF SCIENCES

PRELIMINARY PROGRAM OF SCIENTIFIC PAPERS FOR THE AUTUMN MEETING, NOVEMBER 15–17

THE National Academy of Sciences will hold its stated autumn meeting at the American Museum of Natural History, New York City, on November 15, 16 and 17. The council will meet at 4 P.M. on Monday, November 15. There will be a lecture on "The Problem of Aerial Transmission" by Professor M. I. Pupin, of Columbia University, at 8 P.M., followed by a reception in the museum. On Tuesday and Wednesday morning at 9:30 A.M. there will be business sessions of the academy, followed at 10:30 by public scientific sessions. On the afternoon of November 16, there will be four papers of general interest. On the afternoon of November 17, luncheon will be served at the New York Zoological Park, followed by a visit to the New York Botanical Garden and afternoon tea. There will be a dinner on the evening of November 16 at the Chemists' Club.

The preliminary program of scientific papers is as follows:

The Nature of Cell Polarity: EDWIN G. CONKLIN.

Heredity of Stature: CHAS. B. DAVENPORT.

Parental Alcoholism and Mental Ability, a Comparative Study of Habit Formation in the White Rat: E. C. MACDOWELL. (Introduced by CHARLES B. DAVENPORT.)

The purpose of this investigation is to compare the mental capabilities of rats whose parents were

alcoholic with those of rats of normal parentage. It is commonly claimed that in man, the children of alcoholics are less teachable than children of normals. However, the exceeding difficulty of obtaining genetically comparable controls in man makes the study of a lower animal, although vastly different psychologically, of great interest, since double first cousins—the closest relationship possible for such comparisons—can be used. The first criterion used for judging mental activity has been habit formation in a Watson puzzle box. The habit to be learned consists of a trip around behind the box, breaking an electric circuit and so opening the front door, and returning to the front, entering the box for the reward of food. The data recorded consist in the times required to open and enter the door of the puzzle box. Each rat has been given 225 trials; 145 rats have been employed in this training. The data, summarized in various ways, have been represented by graphs. Awaiting the results of a second set of training experiments of a different nature, which are being conducted as a check on the first method, no general conclusions are given and only provisional conclusions are drawn about the present work.

Rôle of the Lymphocytes in Resistance to Cancer: JAMES B. MURPHY. (Introduced by JACQUES LOEB.)

Experimental Observations on Certain Phenomena of Growth: THOMAS B. OSBORNE and LAFAYETTE B. MENDEL.

The growth impulse, or capacity to grow, can be retained and exercised at periods far beyond the age at which growth ordinarily ceases. In the case of our experimental animals, albino rats, in which increment of body weight ordinarily ceases before the age of 300 days, resumption and completion of growth was readily obtained at an age of more than 550 days. It is now reasonable to ask whether the capacity to grow can ever be lost unless it is exercised. Even after *very prolonged* periods of suppression of growth, the animals can subsequently reach the *full size* characteristic of their species. In this respect there is no impairment of the individual. The satisfactory resumption of growth can be attained not only after stunting by underfeeding, but also after the cessation of growth which results when the diet contains proteins unsuitable for the synthetic processes of growth or is low in protein. Growth in the cases referred to is resumed at a rate normal for the size of the animal at the time. It need not be slow, and frequently it actually exceeds the usual progress. The size or age at which the inhibition of growth is effected does not alter the capacity to resume growth. Even when the suppression of growth is attempted for very long periods at a very small size (body weight) the restoration may be adequate when a suitable diet is furnished. The procreative functions are not necessarily lost by prolonged failure to grow before the stage of development at which breeding is ordinarily possible. The period of growth may be greatly prolonged by inadequacies in the diet, so that growth becomes very slow without being completely inhibited. Though the time of reaching full size is thus greatly delayed, growth, as expressed by suitable body weight, can ultimately be completed even during the course of long-continued retardation. The methods of partially retarding or completely suppressing growth are too varied and unlike to permit final answers as yet regarding the outcome of all of the procedures of inhibition for the subsequent welfare of the individual. Our observations apply to the effects upon size and a few other incidental features mentioned. Although it is doubtful whether the fundamental features will be altered, far reaching dogmatic statements are scarcely justifiable until the experiments have been extended to include other factors and animal species. A detailed account of the work will appear in an early issue of the *Journal of Biological Chemistry.*

The Calorimeter as an Interpreter of the Life Processes: GRAHAM LUSK.

The measurement of the heat production in fermentation of sugar by yeast cells indicates a height of cellular activity, approximating that possible in the cells of mammalian tissue as has been shown by Rubner. The basal heat production in an adult man is very closely proportional to the surface area, although the age of the organism also plays an important part in this regard. In only a very few conditions of disease is the heat production decidedly changed. Thus, in conditions such as fever and exophthalmic goiter there is a largely increased heat production. Fortunately the ingestion of food under these circumstances does not cause a greater heat production than such food would effect if given to a normal man. In all diseased conditions there is no departure from the manner of utilization of the important food stuffs, with the striking exception of diabetes.

Ultramicroscopic Study of the Fibrin-gel: W. H. HOWELL.

The fibrin formed in the coagulation of blood has been described as consisting of a coarse net-

work of fibrils, but examination of the clot under the ultra-microscope demonstrates that it is deposited as a meshwork of needles or crystals, which are formed separately and subsequently cohere to make a firm gel. The traditional fibrin network must be considered as an artefact produced by mechanical stress. In diluted plasmas or in solutions of fibrinogen made to clot by the addition of thrombin, the process of formation of the needles can be followed to a certain extent. They develop by the aggregation of amicrons to form visible particles which assume quickly the shape of short rods. These latter may exhibit at first very active movements, more abrupt and extensive than the ordinary Brownian movements. The minute rods lengthen into needles presumably by accretion, although the actual process can not be followed. The retraction of the clot is one of its characteristic properties and must be referred to a slow condensation of the needles due to a closer aggregation of the particles. A moderate concentration in hydroxyl-ions in the fibrinogen solutions or plasmas increases the degrees of dispersion of the colloidal particles, and in this condition the addition of thrombin causes the formation of a gel of an entirely different character. This gel is nonretractile and under the ultra-microscope reveals no visible structure. Neutralization or slight acidification, insufficient to precipitate the fibrinogen, restores the property of giving fibrin-needles by interaction with thrombin. With the exception of the gels of the sodium salts of the fatty acids described by Zsigmondy, fibrin is the only gel formed by an emulsion colloid which exhibits clearly a vectorial or crystalline structure. As far as the observations have been carried, this peculiar characteristic is exhibited by the blood of all the vertebrates. In the blood of invertebrates (crustacea), a different gel is formed in clotting.

Origin of the Flight of Birds: C. WILLIAM BEEBE. (Introduced by HENRY FAIRFIELD OSBORN.)

Mr. Beebe has discovered both in the young of living birds and in *Archæopteryx* a series of powerful flight feathers on the hind limb, which he will demonstrate in support of a new theory of the origin of the flight of birds.

Ornithological Survey of the Andes and Western Coast of South America: FRANK M. CHAPMAN. (Introduced by HENRY FAIRFIELD OSBORN.)

The ornithological survey of the west coast of South America and of the Andes is now in its fourth year. It is organized along the lines which the United States Biological Survey has introduced in this country. Dr. Chapman will present a *resumé* of the methods of exploration of the area already covered and of the principal results attained in regard to the origin and geographic distribution of the bird life of western South America.

The Archegonium and Sporophyte of Treubia insignis Goebel: DOUGLAS HOUGHTON CAMPBELL. (To be read by PROFESSOR COULTER.)

Treubia is a remarkably large liverwort discovered by Goebel in western Java. It has since been found in several widely separated regions. The writer discovered it on Mt. Banajao, Luzon, the only station yet reported for the Philippines. The material for the present paper was collected by the writer at the original station, Tjibodas, in western Java, in 1906. The archegonium differs from that of other liverworts in the increased number of rows of peripheral cells in the neck, there being always more than six. The young embryo has a large haustorium, much like that found in *Podomitrium* or *Pallaircinia*. The foot is not clearly delimited, and the differentiation of the sporogenous tissue takes place at a later period than is usual. No elaterophore is present, and no definite relation of spore mother-cells and elaters can be detected. The elaters finally become very long. A very massive calyptra is developed. The ripe capsule is ovoid in form, and opens by four somewhat irregular valves. *Treubia* probably is the nearest to the typical leafy liverworts (*Acrogynæ*), of any anacrogynous liverwort.

Fossil Calcareous Algæ from the Panama Canal Zone, with Reference to Reef-building Algæ: MARSHALL A. HOWE. (Introduced by N. L. BRITTON.)

After referring to the recent marked development of interest in the fossil calcareous algæ and the increasing recognition of their importance in the formation of limestones, the speaker will discuss in some detail certain Lithothamnieæ, collected in Pleistocene and Oligocene strata of the Panama Canal Zone by T. Wayland Vaughan and D. F. MacDonald, of the United States Geological Survey. Lantern slides will be shown illustrating the habit and microscopic structure of three species which are to be described as new. One of these, from the Pleistocene flats near Mt. Hope, the speaker considers to be represented also by living specimens found by him in the Colon region, only a few kilometers distant. The other two, from the Oligocene, perhaps find their nearest relatives in certain fossils from the Tertiary of Austria.

Sterility in Plants and its Inheritance: A. B. STOUT. (Introduced by N. L. BRITTON.)

The different types of sterility are discussed as a basis for the presentation of data on the phenomena of self and cross sterility involving physiological incompatibility. The evidence pertaining to the behavior and inheritance of this type of sterility in the flowering plants is summarized and original data presented giving the results of controlled self and cross pollinations with *Cichorium Intybus*, which involve nearly 500 plants and 125,000 individual flowers. The existence of self and cross sterility within this species is established, and the appearance of self-fertile plants is reported. Progenies of self-fertile plants have been studied into the third generation exhibiting with respect to self and cross sterility very irregular behavior and most sporadic inheritance.

Recent Explorations in the Cactus Deserts of South America: J. N. ROSE. (Introduced by N. L. BRITTON.)

The field work in connection with the cactus investigation of the Carnegie Institution of Washington contemplated a study of the deserts of not only North America but also of South America, the latter of which had never been thoroughly and consecutively explored. Two seasons have been given to South America, where an enormous amount of material has been gathered. The three following great deserts have been explored: First, the desert of western Argentina. This includes all of western Argentina. It resembles in its component parts the deserts of Arizona. Second, the desert of central Brazil. This is composed of the western parts of the states of Bahia and Pernambuco. It is very similar to the desert region of Santo Domingo, and the typical genera are nearly all West Indian. Third, the desert of Peru and Chile. This comprises all of western Peru and northern Chile. Its flora is the most distinct of any of the South American deserts.

Some Factors Affecting the Inheritance Ratios in Shepherd's Purse: GEO. H. SHULL. (Introduced by CHAS. B. DAVENPORT.)

The Respiratory Ratio of Cacti in Relation to their Acidity: HERBERT M. RICHARDS. (Introduced by R. A. HARPER.)

Some Studies in Morphogenesis: R. A. HARPER.

Can We Observe Organic Evolution in Progress? HERBERT S. JENNINGS.

Orthogenesis in Plants: JOHN M. COULTER.

The gymnosperms furnish the best illustrations among plants of what is called progressive evolution, or orthogenesis. Many lines of advance can be traced in unbroken series from the Devonian to the present time, involving structures that have been assumed to be beyond the influence of external conditions. Three such lines are used as illustrations. (1) *The Egg.*—In the history of gymnosperms there is a gradual shifting of the time of appearance of the egg in the ontogeny of the gametophyte. In the most primitive forms the eggs appear at the full maturity of the gametophyte. An unbroken series can be traced, representing an earlier appearance of eggs, extending from full maturity of the gametophyte, to very early embryonic stages. Experimental work upon sexuality in plants has shown that the appearance of gametes is in response to certain conditions of metabolism, and these conditions are associated with minimum vegetative activity. Any change of conditions shortening the period of vegetative activity would thereby hasten the appearance of eggs in the ontogeny of the gametophyte. This is exactly the result that, in the case of gymnosperms, would follow the differentiation of the year into definite seasons. The conclusion is that orthogenesis in this case holds some relation to the evolution of climate. (2) *The Proembryo.*—A similar illustration of progressive evolution is offered by the earlier and earlier appearance of wall-formation in the development of the proembryo, until the stage of free nuclei is eliminated. Since the progressive changes in the appearance of eggs and the development of the proembryo in general proceed *pari passu*, the inference is that they are both responsive to the same changing conditions. (3) *The Cotyledons.*—Recent work has shown that the number of cotyledons is also a response to conditions affecting vegetative activity. Among the causes that determine the progress from polycotyledony or dicotyledony to monocotyledony, a conspicuous one is the rate of growth of the subsequent members of the embryo, and this rate is a response to conditions for vegetative activity. The general conclusion is that the phenomenon of orthogenesis among plants is to be explained, not as the result of an "inherited tendency," but as a continuous response to progressive changes in the conditions of vegetative activity.

Investigations Recently Conducted in the Wolcott Gibbs Memorial Laboratory: THEODORE W. RICHARDS.

The Life of Radium: B. B. BOLTWOOD.

Experiments and Theory of Conical Horns; Instruments for Measurements of Sound; An Instrument for Finding the Direction of a Fog-signal: A. G. WEBSTER.

The Biography of Alfred Marshall Mayer: ALFRED G. MAYER and ROBERT S. WOODWARD.

The Solar Radiation and its Variability: G. C. ABBOT.

The New Draper Catalogue: EDWARD C. PICKERING.

One of the largest pieces of routine work undertaken at the Harvard College Observatory is the New Draper Catalogue. Its object, primarily, is to furnish the class of spectrum of all the stars so far as they can be determined from existing photographs. This classification was undertaken by Miss Annie J. Cannon, in October, 1911, and, by observations persistently maintained for four years, this portion of the work was practically completed, September 30, 1915. During this period, she classified 233,050 spectra, thus covering the entire sky. Meanwhile, 196,768 of these stars have been identified, and 194,820 of them entered in the card catalogue. The entire work will fill nine of the quarto volumes of *Annals* of the observatory, and will also give photometric and photographic magnitudes of all the stars on a uniform scale.

On the Albedo of the Moon and Planets: HENRY NORRIS RUSSELL. (Introduced by EDWARD C. PICKERING.)

A Possible Origin for Some Spiral Nebulæ: GEORGE F. BECKER.

The paper seeks to show that the spiral, $r^2\phi^2 =$ constant, is of use in interpreting the phenomena.

Concomitant Changes in the Earth's Magnetism and Solar Radiation: L. A. BAUER. (Introduced by R. S. WOODWARD.)

The author's preliminary conclusions respecting appreciable changes in the earth's magnetic state, concomitant with changes in the intensity of solar radiation as shown by Abbot's solar-constant values, are confirmed by a fresh investigation based upon solar and magnetic data for 1913 and 1914. It is found, for example, that decreased solar constant is accompanied by an increase in the constant used to define, at any time, the earth's magnetic state, and by a decrease in the range of the diurnal variation of the earth's magnetism. The numerical relationship between changes in solar constant and magnetic constant, or in the magnetic diurnal range, is shown to be sufficiently definite to strengthen the conclusions reached by Abbot respecting the sun's variability. Diagrams were exhibited showing how, with the aid of the relation found, certain puzzling features respecting the secular variation of the earth's magnetism and its so-called "non-cyclic daily change," may be readily explained.

Experiments on the Mean Free Path of Gases: Observations on Wood's One-dimensional Gas: FRED E. WRIGHT and J. C. HOSTETTER. (Introduced by ARTHUR L. DAY.)

In a paper on "One-dimensional Gases and the Experimental Determination of the Law of Reflection for Gas Molecules," presented before this academy at its April meeting, Professor R. W. Wood directed attention to interesting phenomena which he ascribed to reflection of mercury atoms from an optically plane glass surface. Inspired by this paper it occurred to us to apply Wood's method to crystal plates and to ascertain if the crystal symmetry affects the distribution of the reflected mercury atoms. The experiments, with the exception of two which yielded no results of value, were all performed during the month of May, but the publication of the results has been postponed for reasons beyond our control. Our preliminary results led at once to the construction of a new piece of apparatus by means of which evidence was obtained proving that a large part of the phenomena are to be explained on the basis of the kinetic theory of gases; they show that in high vacua of pressures of only 0.2 bar there is still sufficient gas present to inhibit the formation of "one-dimensional gas." The experiments illustrate, moreover, the change, with pressure, of the mean free path of a given gas. Computations on the basis of the kinetic theory are in agreement with the experimental evidence and serve also to explain the clear zonal ring of no reflection observed both by Wood and by us.

The Water Correction in Conductivity Determinations: JAMES KENDALL. (Introduced by ALEXANDER SMITH.)

Conductivity water, however carefully prepared, can not be kept for more than a few minutes in contact with air without its specific conductivity rising to about 0.9×10^{-6} reciprocal ohms at 25° C. This is the same as the calculated specific conductivity of water saturated with carbon dioxide under its atmospheric partial pressure (3.69 parts in 10,000). It is therefore possible to eliminate entirely the influence of the water in exact conductivity measurements by correction for dissolved carbonic acid. This has been done for very dilute solutions of strong electrolytes (Arrhenius), transition electrolytes (Kendall), and weak elec-

trolytes (Walker and Kendall). The results in all cases confirm the assumption that the correction thus applied is valid and complete.

Extremes of Adaptation in Carnivorous Dinosaurs, Tyrannosaurs and Ornithominius: HENRY FAIRFIELD OSBORN.

Complete skeletons of two of the most remarkable types of carnivorous dinosaurs, *Tyrannosaurus* and *Ornithominius*, are mounted and exhibited especially at this meeting of the academy. Dr. Osborn will describe the two extremes of carnivorous dinosaur adaptation which they respectively represent.

Influence of Certain Minerals on the Development of Schists and Gneisses: C. K. LEITH. (Introduced by C. R. VAN HISE.)

A brief account of the development of quantitative methods in the study of the metamorphic cycle, leading up to a consideration of the formation of schists and gneisses. Evidence is presented to show that the development of schists and gneisses means convergence to a few mineral types, and that the characteristics of a few minerals determine to a large extent the course of chemical, mineralogical and textural changes in dynamic metamorphism.

Sculpture of the Mission Range, Montana: W. M. DAVIS.

The Mission Range, one of the smaller members of the Rocky Mountains in western Montana, composed of deformed rocks, chiefly quartzites, has the appearance of a tilted and dissected fault block, trending north and south, about 70 miles in length. The steeper face, probably representing the battered fault scarp, looks to the west. The low northern crest of the range emerges from the glacial deposits that floor the surrounding intermont depression at an altitude of 3,000 feet, and rises slowly southward with moderate undulation to an altitude of 9,500 feet near its abrupt southern end. The eastern side of the range is said to slope more gently than the steep western face. The present features of the range due to erosion since uplift, as seen from the intermont depression on the west, may be divided into three oblique belts by two nearly parallel south-dipping planes, about 1,000 feet apart. The middle belt has smoothly-rounded summits, and full-bodied, large-textured, waste-covered spurs of mature normal degradation between wide-spaced, steep-pitching, consequent valleys. The upper and southernmost belt includes, besides the rounded, waste-covered forms of normal erosion, bare-walled cirques and troughs of local glaciation in more than a score of its high-reaching valleys; these features are best developed at the high southern end of the range, where the crest is locally sharpened into Alpine arêtes, and where the troughs, encroaching most broadly on the intervening spurs, reach down to the mountain base; at the middle of the range where its height is less, the cirques are faintly developed and the troughs extend only a few hundred feet down these valleys. The lower and northernmost belt shows many crags and knobs, cliffs and ledges, channels and hollows due to erosion by a broad and overwhelming glacier of Canadian origin. The northern half of this belt, or roughly, the northernmost fourth of the range, lies entirely beneath the slanting limit of Canadian glacial action, and is of disorderly form to its crest; the northernmost knobs, more or less detached from one another, rise hardly a hundred feet above the gravel plain: the southern half of the belt, in the second fourth of the range, preserves rounded normal forms along its crest and lower and lower down on its flanks as mid-range-length is approached; its valleys are barred across by morainic embankments along the slanting limit of the Canadian glacial action, and its spurs are imperfectly truncated in rugged facets which descend abruptly into Flathead lake. The height of the facets and the altitude of the embankments decrease southward; the facets become smaller and less continuous; the embankments become longer, larger and more continuous, until, curving away from the range base they unite in a noble terminal moraine, 400 or 500 feet in height and a mile or more in breadth, which swings westward across the intermont depression, separating Flathead lake on its northern concave side from the Mission plains of earlier glaciation on its southern, convex side. As far as I have seen and read, the Mission range is unique in its systematic tripartite arrangement of normal and glacial features.

Crystallisation of Quartz Veins: WALDEMAR LINDGREN.

The Minor Constituents of Meteorites: GEORGE P. MERRILL. (Introduced by A. L. DAY.)

A Peculiar Clay from near the City of Mexico: E. W. HILGARD.

KARL EUGEN GUTHE

AT the first meeting of the year the president of the Research Club of the University of Michigan read the following words of appreciation of the late Professor Guthe:

It is very fitting at this meeting, the first of the Research Club since the death of one of its specially honored members, Karl Eugen Guthe, that some words of appreciation should be spoken and I know well that in what I shall say now I shall have the hearty consent and sympathy of the whole club.

Sixteen years—1893 to 1903[1] and 1909 to 1915—a teacher in the university, nine years an active member of this club, and three years the dean of the graduate school, Dr. Guthe won for himself an unusually general and unusually cordial respect. His fine character, his high ideals, his constant loyalty to careful scholarship and scientific research made him a man whom it has been a benefit to us all to have known and to whom the university in its work as an educational institution and in its larger life, where the man as well as the teacher and officer makes himself felt, is indebted greatly.

It is pleasant to remember Dr. Guthe's last paper before the Research Club, read at the Roger Bacon memorial meeting in April, 1914; a paper on Bacon as a scientist that was a model of conscientious study and critical statement.

It is pleasant, too, to remember how seriously and faithfully he applied himself to the newly organized graduate school, seeking to put it and all its opportunities to the real service of productive study. What he accomplished, moreover, has given the school a most valuable foundation.

And, again, it is pleasant to remember in these days of national and racial differences, when so many are carried away by their partisan feeling, that although often at variance with the opinions and sympathies of many of his friends he neither gave offense to any nor took offense; and this, quite without sacrifice of his independence. He did indeed show, as too few have shown, how science and its methods, its ideals and its purposes, may give men integrity and poise; winning for himself and his views the respect that with his sense of fairness he was so ready to accord to others and to their views.

A true scholar, a faithful and efficient officer, and a most genial friend, Dr. Guthe was one whom we are glad to have had among us and whose memory we may well cherish.

SCIENTIFIC NOTES AND NEWS

A CABLEGRAM from Copenhagen to the daily papers, the correctness of which is open to question, states that the Swedish government will award the Nobel prize in physics to Thomas A. Edison and Nikola Tesla; and in chemistry to Professor Theodor Svedberg.

PROFESSOR ADOLF VON BAEYER celebrated his eightieth birthday on October 31. With the beginning of the present semester he retired from the chair of chemistry at Munich in which he succeeded von Liebig in 1875.

PROFESSOR EDUARD BRÜCKNER has been elected president and Professor Eugen Oberhummer vice-president of the Vienna Geographical Society.

DR. DAVID W. CHEEVER, of Boston; Dr. Wilfred T. Grenfell, of Labrador; Dr. Stephen Smith, of New York; and Dr. Lewis McL. Tiffany, of Baltimore, were elected honorary fellows of the American College of Surgeons at its recent Boston meeting.

ON the occasion of the dedication of the Elizabeth Steel Magee Hospital the University of Pittsburgh conferred its doctorate of laws on Dr. John W. Williams, dean of the Johns Hopkins Medical School; Dr. Barton Cooke Hirst, professor of obstetrics, University of Pennsylvania; and on Dr. Walter William Chipman, professor of obstetrics and gynecology, McGill University.

PROFESSOR HENRY S. JACOBY, of the college of civil engineering, Cornell University, has been elected president of the Society for the Promotion of Engineering Education for the year 1915–16.

PROFESSOR A. H. WHITE has considered it necessary, owing to reasons of health, to resign the chair of pathology in the school of the Royal College of Surgeons in Ireland, which he has held for the last seventeen years.

DR. JOHN CASPER BRANNER, whose resignation of the presidency of Stanford University has been accepted to take effect December 31, will retire on a Carnegie pension and will continue to live on the Stanford campus. He will maintain an office in the university, in accordance with the trustees' invitation, and immediately after his retirement will be occupied for some time in a revision of two of his books, each of which is about to be published in a third edition—his Portuguese

[1] 1903–1905 Dean Guthe was in the Bureau of Standards, Washington, D. C., and 1905–1909 he was professor of physics in the University of Iowa.

grammar and his elementary text-book of geology, written in Portuguese for students of Brazil. In accepting Dr. Branner's resignation and appointing Dr. Ray Lyman Wilbur to succeed him, the Stanford board of trustees expressed "its obligation to Dr. Branner for his long and faithful service to the university and for his self-sacrifice in extending his term of service as president until December 31, 1915, at the urgent request of the board."

As an outcome of the recent Manchester meeting, the British Association has, as we learn from *Nature*, invited the following gentlemen to serve on a committee to consider and report upon the question of fuel economy (utilization of coal and smoke prevention), from a national point of view: Professor W. A. Bone, of the Imperial College of Science and Technology, London (chairman); Mr. E. D. Simon, chairman of the Manchester Air Pollution Committee (secretary); Professors P. P. Bedson (Armstrong College, Newcastle-on-Tyne), J. W. Cobb and J. B. Cohen (Leeds University), H. B. Dixon (Manchester University), Thomas Gray (Royal Technical College, Glasgow), H. S. Hele-Shaw (London), L. T. O'Shea and W. P. Wynne (Sheffield University), and Richard Threlfall (Birmingham), together with Dr. G. T. Beilby (Glasgow), Mr. Ernest Bury and Dr. J. E. Stead (Middlesbrough and the Cleveland district). The committee, which is empowered to add if necessary to its members, has been selected so as to include representative chemists, engineers and technologists from all the principal industrial areas.

AT the third triennial conference of the National Association for the Study of Pellagra held in Columbia, S. C., October 21 and 22, the following officers were elected: president, Capt. Joseph F. Siler, M.C., U. S. Army; vice-presidents, P. A. Surg. R. M. Grimm, U. S. P. H. S., and Henry W. Rice, Columbia, S. C.; secretary, Dr. James W. Babcock, Columbia, S. C., and treasurer, Dr. James A. Hayne, Columbia, S. C.

THE Elisha Mitchell Society, University of North Carolina, elected in October the following officers for the ensuing year: James B. Bullitt, president; T. F. Hickerson, vice-president; and J. E. Smith, secretary and treasurer.

DR. DAVID CHEEVER, of Boston, has been appointed chief surgeon in charge of the third Harvard surgical unit, which leaves this month for France. The unit consists of thirty-six nurses and eight surgeons in addition to Dr. Cheever.

ANOTHER party of American physicians returned to the United States on October 20 aboard the steamer *Cretic*. The members of this party who had been serving in Serbia were Dr. Louise Taylor-Jones, who established a hospital for babies at Nish; Dr. Thomas W. Jackson, of Washington, D. C., who succeeded Dr. Richard P. Strong as head of the American Sanitary Commission in Serbia; Dr. Joseph Thompson, of Cleveland, Ohio; and Dr. George W. Mellon, of Beaver, Pa., who will return to Belgrade after a three weeks' leave of absence in this country.

DR. HENRY A. STRECKER has been appointed chief medical inspector of the Philadelphia Bureau of Health, in succession to Dr. Charles A. Groff.

PROFESSOR HENRY LOUIS RIETZ, of the department of mathematics of the University of Illinois, has been appointed by Governor Dunne a member of the commission that is to investigate the operation of all pension laws heretofore enacted in the state. The commission is also to collect information from this country and foreign lands and is to make a report to the next general assembly.

HENRY B. STEER, a graduate of Cornell University in forestry, has received an appointment for forest work in the Indian Office, U. S. Department of the Interior. He will work on the eastern Cherokee lands in western North Carolina.

PROFESSOR LEONARD HEGNAUR has been appointed soils and crop specialist for field work under the direction of the extension department of the Washington State College.

MR. F. R. WULSIN is returning from Madagascar where he has been for about six months, collecting for the Zoological Museum, Harvard

University, after a long trip in British East Africa for the same purpose.

R. I. Smith, formerly professor of entomology in the University of Porto Rico, College of Agriculture, Mayaguez, has been placed in charge of the Boston office for the foreign cotton quarantine, against the pink boll worm of Egypt and other countries.

Dr. Samuel W. Stratton, director of the United States Bureau of Standards, gave an illustrated lecture before the engineering students of the Ohio State University on November 5, on "The Work of the Bureau of Standards."

Dr. William S. Franklin, recently professor of physics in Lehigh University, lectured before the students of Sibley College, Cornell University, on November 3, on "Some Mechanical Analogies in Electricity and Magnetism," with experiments. On November 5, at a meeting of the local section of the American Institute of Electrical Engineers, he gave a talk "On Electric Waves," with demonstrations and experiments.

Professor Marston Taylor Bogert, of Columbia University, on October 25, addressed the staff and students of the school of chemistry of the University of Pittsburgh and of the Mellon Institute upon "Reminiscences of Famous European Chemists and Chemical Laboratories."

The Swiney lectures on geology in connection with the British Museum (Natural History) will be delivered by Dr. J. D. Falconer, beginning November 13. There will be twelve lectures on "Ice and the Ice Age."

The lectures before the Royal College of Physicians of London this autumn are as follows: The Bradshaw Lecture, by Dr. Mitchell Clarke, on November 2, the subject being nervous affections of the sixth and seventh decades of life; the FitzPatrick Lectures on November 4 and 9, by Dr. W. H. R. Rivers, on medicine, magic and religion; and the Goulstonian Lectures, by Dr. Gordon Holmes, on November 16, 18 and 23, on acute spinal lesions, with special reference to those of warfare.

Brigadier-general George M. Sternberg, retired, surgeon-general of the army, from 1893 to 1902, distinguished for his investigations of yellow fever and other diseases, died at his home in Washington, on November 3, at the age of seventy-seven years.

Wirt Tassin, formerly chief chemist and assistant curator of the division of mineralogy, U. S. National Museum, since 1908 a consulting metallurgist at Chester, Pa., known for his contribution to mineralogy and metallurgy, died on November 2, at the age of forty-six years.

Dr. William Noyes, for fifteen years superintendent of the Boston Insane Hospital, known for his work on neurology and psychiatry, died on October 20, at his home in Jamaica Plain, aged fifty-eight years.

Felix Leconte, professor in physical and mathematical sciences at the University of Ghent, died in London on October 11, aged fifty years.

As a result of the explorations of the Siberian expedition of the Museum of the University of Pennsylvania, the university will shortly be the possessor of a valuable collection of ethnological specimens from the primitive Tungus tribes in the arctic regions of Siberia, and the scientific world enriched by writings and data on a branch of the Mongolian race of which hitherto virtually nothing has been known. More than 700 miles were traveled by the explorers through a country almost without food and sometimes with a temperature as low as 80 degrees below zero. The University Museum's Amazon Expedition has forwarded an account of its discovery of the original habitat of the Monduruсus Indians, a little-known tribe of savages who behead their enemies and then boil the heads. Dr. William C. Farabee, who is in charge of the expedition, spent a long time among the Mundurucus, studying their language, their manners and customs and making a vocabulary and writing down much of their folk-lore, as a result of which he expects to settle absolutely the long vexed question of the relation of this tribe to the Tupi. He also visited villages of

the Apiacas and Manes and got important data.

IN connection with the twentieth anniversary celebration of the New York Botanical Garden, Miss Caroline Coventry Haynes presented to the Garden the collection of Hepaticæ formerly belonging to Dr. Marshall A. Howe, from whom she purchased it in 1909. This collection is especially rich in Californian material and includes most of the specimens described or cited by Dr. Howe in his memoir on "The Hepaticæ and Anthocerotes of California," published in 1899. The collection includes, besides, a considerable amount of foreign material received in exchanges with Schiffner, Levier, Heeg, and other European students of the Hepaticæ. The pockets of specimens now turned over to the Garden number 1,174. The Ricciaceæ of this herbarium had already been deposited at the Garden. Certain specimens belonging to groups in which Miss Haynes is especially interested are being retained by her for a time, making the total number of pockets of specimens that are eventually to come to the Garden about 1,851. The New York Botanical Garden has received also one thousand dollars from the executor of the will of Jacob Langeloth, and this legacy has, by order of the board of managers, been credited to the principal of the Endowment Fund for Science and Education, increasing this fund to $76,455.

AMONG the resources of California of great potential value and as yet only slightly developed are the mineral springs which abound in many parts of the state. Streams of pure water issue in large volume from the northern lava fields, but some of the desert springs yield strong brines. Some mountain regions yield springs of ice-cold water in mid-summer, and in the same vicinity are pools of vigorously boiling water. Water so corrosive that clothing soon falls to pieces under its action is common in some localities; in others issue springs of hot, soft water excellent for laundry use. Several of the more noted springs are mere trickles of pleasant-tasting carbonated water; other and larger springs of more delicious natural "soda water" are at present remote from roads and are known only to the hunter and prospector. Many springs form deposits of salt that are welcomed by cattle and wild animals as "deer licks"; others are a menace to small life because of the purgative salts they contain or of the great amount of carbonic-acid gas they give off. The chemical constituents produce notable coloring in many waters, giving in some springs shades of yellow, green or blue, and at one place a milky and an inky-black stream issue side by side. In connection with studies of other phases of the water resources of California G. A. Waring, of the United States Geological Survey, made an examination of the springs, and the results are embodied in Water-supply Paper 338. Of the 600 springs described in this paper, more than 100 are used to greater or less extent as resorts, but only about one third of this number have been patronized primarily for the curative value of their waters, the others being noted chiefly as pleasure resorts. At a few, however, equipment comparable with that of the well-known European spas is in use and advanced practise in therapeutic treatment is employed.

RUBBER manufacture involves the use of numerous poisonous substances, of which lead salts, antimony pentasulphide, aniline oil, carbon disulphide and carbon tetrachloride are the most dangerous. The operations involving exposure to these poisons, however, employ but a small proportion of the large number of workers. No women and very few boys are engaged in such operations. A lesser danger is found in the use of coal-tar benzol and of various petroleum products, such as naphtha, benzine, etc. A considerable number of the workers, including women and boys, are exposed to the fumes of these compounds. These facts are brought out in an investigation by Dr. Alice Hamilton of the industrial poisons used in the rubber industry, the results of which have just been published as Bulletin 179 of the Bureau of Labor Statistics of the Department of Labor. While it was impossible to get complete data as to the frequency of industrial poisoning in the rubber industry, records were secured of no less than 66 cases

of lead poisoning which occurred in 1914 among the rubber workers in the United States. Cases were also found of naphtha poisoning, and of poisoning from carbon disulphide, carbon tetrachloride and aniline oil. The dangerous nature of some of the compounds used in the rubber industry is not as yet commonly known, so that cases of industrial poisoning may occur without being recognized as such and ascribed to their true cause. Also, in the case of some of the compounds, the symptoms of poisoning may be obscure or may not develop until some time after the exposure has taken place, so that again the resulting harm may not be ascribed to its true cause. The investigation on which the bureau's report is based covered 35 rubber factories, located in fifteen cities or towns in nine states. Practically every branch of the rubber industry was included among the activities of these factories. The processes of rubber manufacturing are many and various and there is a great difference in the extent to which men and women employed in the different branches are exposed to the danger of poisonous dusts and fumes.

UNIVERSITY AND EDUCATIONAL NEWS

By the will of the late A. F. Eno, his residuary estate, which may be very large, is bequeathed to Columbia University.

The American Association of University Professors will hold its annual meeting in Washington, D. C., on Friday, December 31, 1915, and Saturday, January 1, 1916. Besides routine business, the principal matters to come before the association at this meeting will be the final adoption of the constitution, and the presentation and discussion of the general report and declaration of principles of the Committee on Academic Freedom and Tenure of Office.

Professor Cornelius Betten, formerly with Lake Forest College, Illinois, is now on the faculty of the New York State Agricultural College, Cornell University.

Herman J. Muller, a student in the department of zoology of Columbia University, has been appointed instructor in biology at the Rice Institute, Houston, Texas.

Dr. George von Pullinger Davis has gone to Salt Lake City as professor of physiology in the University of Utah.

Dr. Leo Loeb has been appointed professor of comparative pathology in the medical school of Washington University.

DISCUSSION AND CORRESPONDENCE

THE POSITION OF REFERENCES IN JOURNAL ARTICLES

To the Editor of Science: The subject of Mr. Heyward Scudder's letter in Science for October 1 (p. 454) is one that has long interested me as author, as editor and as secretary of the British Association Committee on Zoological Bibliography and Publication. I therefore venture a few comments on his proposals.

It happens that I have just had to see through the press an article furnished with references in the precise manner desired by Mr. Scudder. The article, however, was so long that it had to be spread over three monthly parts of the periodical to which it was sent. Thus, on the proposed plan, the reader of the first two parts would have to wait one or two months for the references—a course that was quite inadmissible. This illustrates one frequent objection to the proposals. Mr. Scudder himself admits others, even when the article is less lengthy.

There are two sets of people to be considered: on the one hand, the editor and publisher; on the other, the author and his readers. Mr. Scudder's main argument is the saving to the former, but the utmost saving that he claims does not amount to one per cent., and the average of all his actual instances shows a less saving than half a page in a hundred. That amounts to 31 sheets in an edition of 1,000 in octavo. The total pecuniary saving from the paper bill and the printer's bill would thus be about two dollars, which equals one fifth of a cent per copy. The more important journals, which begin each article on a fresh page, would rarely effect any saving in paper.

This trivial saving may, I venture to think, be disregarded, and the question decided purely in the interests of the reader. Now the reader wants one or all of three things: first, a speedy reference from the quoted statement to the authority; secondly, a name and a date that will appeal at once to his historical sense and furnish him with some idea of the present value of the statement; thirdly, a conspectus of the so-called "literature" arranged in some logical order. Whatever the merits of Mr. Scudder's proposals, they provide the reader with none of these things. Their merits are twofold: they get rid of references at the foot, which are expensive and encourage the vicious habit of putting matter into footnotes because the author will not be at the pains to rehandle his text; and they do away with *loc. cit.*, which is not merely wasteful, but more often than not erroneously used in place of *op. cit.* or *tom. cit.*

In offering counter-proposals it is advisable to distinguish between two classes of papers: first, brief articles in which the references are correspondingly few and rarely repeated; secondly, long articles or memoirs in which the references are correspondingly numerous and frequently repeated. In articles of the first class, references may quite easily be worked into the text, and can be repeated by giving the cited author's name, with a distinguishing date when more than one of his works has been mentioned. For memoirs of the second class it is certainly convenient for both author and reader to have a "list of works referred to" at the end (or sometimes at the beginning) of the memoir. But though it may save trouble to the author to number these works in the order of their citation, this will save nothing to the reader, for that order has often no meaning apart from the text. Here is an actual example: 1. Tegner, 1880. 2. Jespersen, 1913. 3. Johannsen, 1913. 4. Anon., no date. 5. Höffding, 1910. 6. Höffding, 1914. 7. Goethe, 1858. 8. (Another page of 3.) 9. Anon., 1873. 10. Rádl, 1913. 11. Bernard, 1867, and so on for nearly 100 items. To use such a list as a guide, or to look up an author in it, is difficult enough as it is, but would be more so if the items were separated only by a 5 mm. space (a mutton-head, as our printers call it). The most convenient plan for subsequent reference is to give the authors in alphabetical order, with the papers by each in chronological order. The references in the text will then be simply: TEGNER (1880), GOETHE (1858, p. 279), CLAUDE BERNARD (1867), H. M. BERNARD (1896, p. 53). Such a mode of reference gives the historical perspective, and is of itself enough to save a reader familiar with the subject from repeated application to the list at the end.

So far as I can see, the methods here outlined (which have no pretensions to novelty) would meet all Mr. Scudder's requirements and need not cost more in either time or money.

F. A. BATHER

BRITISH MUSEUM OF NATURAL HISTORY,
LONDON, S.W.,
October 13, 1915

IN a recent number of SCIENCE[1] Heyward Scudder, in an article with the above heading, calls attention to the fact that from one half to one per cent. of the space in the majority of scientific journals giving many references is wasted by the faulty position and arrangement of the references. He recommends, as a means of saving this space, that each reference be given a number (the numbers to run consecutively) and that all references be printed at the end of the article, leaving an extra wide spacing between the period at the end of one number and the next number, in order to catch the eye.

It is quite possible that the method suggested would effect a small saving in space. It would seem, however, that the desirability of this method of giving references is open to discussion.

It must be conceded at the outset that the matter is largely one of personal opinion, and that one of the hardest tasks of a conscientious editor is to edit consistently the references of his journal. Furthermore, no two journals, unless published under the same supervision, have the same system of references. Certainly no two papers, unless by the same author, will give references in exactly the same way and

[1] SCIENCE, 1915, XLII., 454, October 1.

even in the same paper one may find differences. Because of this it is not surprising that all of us do not agree with Scudder.

Our position is stated in the directions given for the "Placing of References" as found in *Bibliographic Style*, published by the American Medical Association.

All comments or bibliographic references (except footnotes that concern the article as a whole) on various matters mentioned in an article should be used as individual footnotes, numbered consecutively throughout the article, each to be placed at the foot of the required column (or page), rather than grouped at the end as a bibliography. The latter method may be followed, however, if an author desires merely to give a general survey of the literature on the subject. When the same reference is used twice, instead of duplicating the note or using the words "*loc. cit.*," it is better to repeat in the text the reference number of the original note.

References are given for the convenience of the reader. In general they are specific in character and the reader desires to consult them in connection with the particular point in question and not in a general way. It is more economical of time from the reader's point of view to have references at the foot of the page, where they may readily be consulted, than at the end of the article, which necessitates the turning of an indefinite number of pages every time a reference is needed. This is especially true in those cases where it is necessary to find a reference to a particular fact. One looks through the article in question until the desired point is found and then, by glancing at the foot of the page, at once finds the reference.

While this is a personal opinion the writer finds that it is shared by a number of his fellow-workers. If the method suggested by Scudder is as convenient as he would have us believe, it is surprising that more of the journals written by and for busy scientific men should not have adopted it. To our knowledge the only journal that consistently uses Scudder's method is the *Biochemical Journal*.[2] The journal recently founded by Dr. V. C. Vaughan, *The Journal of Laboratory and Clinical Medicine*, apparently uses, in part at least, the same system of reference-giving in the original articles (it may be at the author's discretion), but uses the more convenient form of references at the foot of the page in the editorial section.

Another point made by Scudder in favor of grouping references at the end of the article is that this method assists one in looking up original references, in that it saves time in the long run. References are individual and are found in different magazines or in different volumes of the same magazine. In the interval between looking up two original articles it is just as easy, or easier, to turn a page or two to find the next numbered reference, as it is to locate one's place in a running paragraph of references, printed in eight-point or even in smaller type.

In this connection it may be permissible to call attention to one aspect of the question which would really effect a saving of time. Much annoyance and loss of time is caused by the inaccurate quotation of references. The degree of inaccuracy may be either a wrong page number, a wrong volume number, or a wrong journal. Sometimes the error is easily corrected, but more frequently it is not. Because it is so easy to make mistakes of this kind, it is only just to the reader that all references be carefully checked in the manuscript and verified in the galley proof. In very few cases does the journal publishing the article verify the reference, so the burden and the blame usually fall upon the author.

As a rule, journals are desirous of pleasing their contributors and readers and will print references as given. The question of saving one per cent. of the space would probably give way to the question of convenience to the reader. Since each contributor has the right to decide for himself, we have felt it worth while to emphasize the old way of giving references, as opposed to Scudder's modification, especially since it seems to be by far the better way.

CLARENCE J. WEST

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH,
NEW YORK

[2] This journal uses a modified form, since a separate line is given for each reference.

INJECTIONS OF THE BUNDLE OF HIS

A SENSE of justice and the firm conviction that publicity can alone correct similar errors prompt me to speak in behalf of my former associate, Dr. Lhamon. The following statement is supplementary to a short foot-note accompanying a paper by M. R. King in the *American Journal of Anatomy* for 1916.

In August, 1911, my former teacher and colleague, Professor W. G. MacCallum, accompanied by Dr. K. M. Vogel, paid a friendly visit to my laboratory in the presence of my former colleague, Professor Zinsser. During this visit Professor MacCallum showed keen interest in, and appreciation of, some specimens of bovine and sheep hearts in which the sheath of the sino-ventricular bundle had been injected with India ink, etc., by my former associate, Dr. Lhamon. Dr. MacCallum inquired especially after the method of injection because he considered it of probable use in connection with demonstrations on pathological human hearts.

Under date of October 24, 1911, Dr. B. S. Oppenheimer, then fellow in pathology with Professor MacCallum, wrote me, saying:

> Dr. MacCallum, in whose department I am doing heart work, told me that you had a method of demonstrating beautifully the auricular-ventricular system by injecting certain substances with a hypodermic syringe. It would save me a great deal of time if I could use such a method in my examination of pathological hearts, etc.

I replied to this letter, briefly explaining Dr. Lhamon's method, referred Dr. Oppenheimer to Dr. Lhamon, giving the latter's address, and added that Dr. Lhamon's article was to appear in the *American Journal of Anatomy*.

In the *Proceedings of the New York Pathological Society*, New Series, Vol. XI., Nos. 5 and 6, pages 130–132, 1911, Dr. Alfred Einstein Cohen, fellow in pathology with Professor MacCallum during 1910–11 and a friend and predecessor of Dr. Oppenheimer, is officially reported to have given a "demonstration of ox hearts showing injection of the conductive system." In discussing this paper Dr. Oppenheimer is officially reported as having said:

> After hearing of the method through Dr. MacCallum I injected a few hearts of ungulates with India ink and water, etc. (*l. c.*, p. 131).

Since according to the official published reports Professor MacCallum was then president of the society he can no doubt testify to the accuracy of the facts reported there if these were in question.

In a personal letter written to me at his own initiative on January 5, 1915, Dr. Cohen admits responsibility for the publication of the above report, but pleads that he acknowledged Lhamon's priority—two years after having anticipated Lhamon's work by his own publication. Dr. Cohen further pleads that this report can not be regarded in the light of a publication, although the *Transactions of the New York Pathological Society* are published regularly, received by several libraries and are listed in the Index catalogue and the Index Medicus, etc. Dr. Cohen adds that hence "neither Dr. MacCallum nor I can be held responsible for an indiscretion."

Dr. Cohen also says in this letter that

> it is stated, furthermore, in Dr. Oppenheimer's discussion that both of us (Drs. Cohen and Oppenheimer) had heard of A-V. bundle from Dr. MacCallum.

As a matter of fact Dr. Oppenheimer is officially reported as having said that

> After hearing of this method through Dr. MacCallum *I* (not *we*, as Dr. Cohen would have it), injected a few hearts of ungulates with India ink diluted with water, etc.'' (*l. c.*, p. 131).

Although Dr. Cohen frankly admits having heard of Dr. Lhamon's work and stated in a personal letter written four years later "that so far as priority is concerned not only I but every one acquainted with the subject gives and has given full credit to Lhamon" he nevertheless claims "that an injection of the right side of the heart was made and published for the first time by me." This false claim was made by Dr. Cohen in *1915* in spite of the fact that Lhamon three years before (*Am. Jr. Anat.*, Vol. 13, 1912, p. 63) stated that "with the sheath system in the right ventricle similar results were obtained, etc." That is,

Dr. Cohen frankly admits that he heard of Lhamon's work and that Dr. Lhamon is given priority by everybody including himself and then claims priority for himself for the right side of the heart! As a matter of fact Lhamon's specimens showing injections on both sides, which are still in this laboratory, and which were described in his paper, were made over half a year before Dr. Cohen heard of how they were made through Drs. MacCallum and Oppenheimer.

Dr. Lhamon's manuscript on "The Sheath of the Sino-ventricular Bundle" which is still on file, was finished on July 22, 1911, and officially accepted for publication in the *American Journal of Anatomy* on November 3 of the same year. Because Dr. Lhamon had left the United States to accept an assistant professorship in the Philippine Medical School in August, 1911, a clerical error in the address caused a delay of several months in the return of the manuscript to the publishers. Hence the article did not appear till March, 1912, three months after Dr. Cohen's publication.

It is significant that there also is internal evidence in Dr. Cohen's report and in Dr. Oppenheimer's discussion which clearly betrays the origin of their ideas. But comment upon this is unnecessary and I make this statement of the facts only in the interests of truth and in justice to Dr. Lhamon and this laboratory.

A. W. Meyer

Stanford University,
September 20, 1915

THE PISTILLATE SPIKELET IN ZEA MAYS

Hunt[1] makes the statement that in the pistillate spikelet in *Zea Mays*, each spikelet is two flowered, the lower one being abortive. Our most recent work on the grasses, by Hitchcock[2] contains a similar statement, as do all of the other botanical text-books examined which treat of this subject. The prevailing idea seems to be that the pistillate spikelet in this species never contains more than one well-developed flower.

[1] "Cereals in America," p. 147, Orange Judd Company, 1904.

[2] "A Text-book of Grasses," p. 161, The Macmillan Company, 1914.

I had occasion some time ago to prepare material of corn spikelets for a class in systematic botany, and as I was growing the Country Gentleman variety of corn in my garden at the time, I used this. I was unable, however, to find any indication of the sterile flower in many of the spikelets, which led to closer observation. I soon discovered that some of the spikelets had two well-developed flowers inside each pair of glumes, and that others had but one such flower and another one partially developed. All gradations occurred in the same ear between spikelets with but one well-developed flower and those which had two.

Those who are familiar with this variety of corn will probably remember that the grains are irregularly arranged on the cob in many places, and that they do not always occur in regular rows as is commonly the case in corn. This irregularity is probably due to the fact that the development of the second flower in many of the spikelets tends to throw some of the grains out of alignment.

Alban Stewart

University of Wisconsin

A REMARKABLE FLIGHT OF CADDIS FLIES AND CHIRONOMIDS

On the evening of September 8, 1909, while the writer was crossing the upper part of Currituck Sound, N. C., the air seemed filled with flying insects. They were so numerous over the water that vision was restricted to a much shorter radius than usual. The constant impacts of the insects against the face became annoying, the more so that they maintained their frequency throughout the six-mile sail across the sound.

Early the next morning I boarded the small steamer *Comet*, which had come from many miles down the Sound during the night. On this boat there was plentiful evidence of the swarm of insects. There was a layer of insects between the glass cover and the poster, concealing the print in every one of the framed shipping regulations and notices of various kinds about the steamer. How the

little creatures crowded into such small spaces is a marvel, but it is proof also of the extreme abundance and all-pervading character of the swarm.

The large lamp in the cabin, with a chimney of a capacity of perhaps a gallon, I was told, had been snuffed several times by the crowding insects. On a spread newspaper nearby lay a pile of the insects which had been dumped from the chimney. There were fully enough to have completely filled the chimney—an innumerable mass. From this collection I gathered some specimens for identification. The Chironomids, which were largely in the majority, have been identified by J. R. Malloch as *Chironomous halteralis* Coquillet, *C. modestus* Say, and *Tanytarsus* sp. The Trichoptera identified by Nathan Banks are *Œcetina incerta* Walker, and *Oxyethira dorsalis* Banks. No representatives of other orders were noted.

W. L. McAtee

ON THE NOMENCLATURE OF ELECTRICAL UNITS

The present cumbrous method of describing the electrical units in the electrostatic and electromagnetic systems suggests the advisability of the adoption of an abbreviated nomenclature which, while being simple, may be sufficiently descriptive. An attempt in this direction has been made by Messrs. Franklin and MacNutt in their text-book "The Elements of Electricity and Magnetism." In it "ab," the first syllable of the word "absolute," is prefixed to the names of the practical units to designate the corresponding units of the electromagnetic system. It appears to the writer that a similar abbreviation might with advantage be employed in the case of the electrostatic system, and he suggests the use of the prefix "es" for the electrostatic system and, possibly, the use of the prefix "em" instead of "ab" for the electromagnetic system. Thus the elementary charge of electricity would no longer be described as "4.7×10^{-10} electrostatic units of quantity (or charge)," but as "4.7×10^{-10} escoulombs." Similarly, the ratio of electronic charge to mass would not be expressed as "1.7×10^{7} electromagnetic units of quantity (or charge) per gram," but as "1.7×10^{7} emcoulombs per gram." Certain written abbreviations naturally follow, thus: esc = escoulomb, emc = emcoulomb, esa = esampere, and so on. This system of nomenclature may be extended to the so-called "rational systems" by using "res" instead of "es" and "rem" instead of "em."

It is hoped that the use of some abbreviated system of nomenclature may become common, and the foregoing is offered as a possible contribution toward that end.

A. E. Caswell

University of Oregon,
October 14, 1915

COOPERATION IN LABELLING MUSEUMS

The Parks Branch of the Department of the Interior of Canada published thirty duplicates of the larger labels of those making up its Handbook of the Rocky Mountains Park Museum. This was done with the intention of offering them through the Museum of the Geological Survey, Ottawa, Canada, to the thirty then known museums in Canada. The survey offered the labels to the museums. Seventeen of them requested certain of the labels and were supplied, being given to understand that these labels were for use only until better labels were available. It is intended to publish from time to time a revised and more complete handbook and to print separates of a larger number of the labels composing it. An edition of at least sixty duplicates will then be desirable, as there are now known to be that many museums, counting both large and small, in Canada.

The writing of the labels and the typesetting of the first edition has already served twenty-two purposes, namely, to produce the handbook of the museum, to partly label the Rocky Mountains Park Museum, to place labels referring to the museum, zoo, paddock and park in the railway station and hotels at Banff, to label some of the animals in the zoo of the park, to label all the local animals in the paddock of the park and to assist in labelling seventeen other Canadian museums. There is a daily prospect of having requests for such

assistance from still other of the sixty Canadian museums. HARLAN I. SMITH

DR. EDWARD HINDLE

TO THE EDITOR OF SCIENCE: In a review of Dr. Edward Hindle's book on "Flies in Relation to Disease—Bloodsucking Flies," by Mr. W. D. Hunter, printed in the issue of SCIENCE for July 16, there occurs the erroneous statement that Dr. E. Hindle met his death in Africa. Dr. Hindle is alive and well and occupies the position of divisional signal officer with the rank of first lieutenant in the Royal Engineers. He is expecting to leave for the front at any moment. It is clear to me that confusion has arisen through the death of Mr. Gordon Merriman, who likewise belonged to my laboratory staff. Mr. Merriman was killed while fighting in Nyasaland. Dr. Hindle has never been in Africa, although before the war we planned for him to go there on a scientific expedition.

Having received many inquiries, from different parts of the world, owing to the misstatement in SCIENCE, I shall be much indebted to you if you will kindly help me to quiet the apprehensions of Dr. Hindle's numerous friends by correcting the error referred to.

G. H. F. NUTTALL

CAMBRIDGE,
October 10, 1915

SCIENTIFIC BOOKS

Bodily Changes in Pain, Hunger, Fear and Rage; An Account of Recent Researches into the Function of Emotional Excitement. By WALTER B. CANNON. New York, D. Appleton & Co., 1915. Pp. xiii + 311.

The Origin and Nature of the Emotions, Miscellaneous Papers. By GEORGE W. CRILE. Edited by AMY F. ROWLAND. Philadelphia, W. B. Saunders Co., 1915. Pp. vii + 240.

It is not altogether an accident that these two volumes, covering ground in many respects very similar, should appear at the same time. For a number of years, and particularly since the publication of Pavlov's work on the effects of emotion upon glandular action, there has been a wide and increasing interest among psychologists and physiologists in the more intimate bodily mechanism underlying emotional processes. This movement has coincided with a rapidly growing appreciation among physiologists and physicians of the organic significance of certain of the so-called ductless glands, and of the physiological importance of gland and muscle tissue in general. Already the discoveries made have quite revolutionized many of the ideas of a generation ago, and the chapter seems hardly more than begun.

Despite the similarity of the two books, it will be convenient to discuss them separately, and we may first consider Dr. Cannon's work, which represents a series of researches carried on by the author in collaboration with a number of his colleagues to whom the book is dedicated. The work gives every internal evidence of having been done with great care and intelligence. The technique pursued is adequately described; the dangers and limitations to which it is exposed are frankly recognized, and the inferences and generalizations proposed are thoughtful and on the whole conservative. The only strictures which a psychologist might be tempted to pass would relate to the large psychological literature on the organic accompaniments of affective states, which is to all intents and purposes wholly disregarded. This may be because it was thought to have no bearing, but to the reviewer this position would hardly seem tenable. In any event, Dr. Cannon's work is written in a manner to inspire the highest respect for its conclusions, whether one wholly agree with them or not.

The essential positions of the author may be summarized in a few propositions, which nevertheless represent very extensive experimentation both of his own and of other scientists. The great divisions of the autonomic system, *i. e.*, cranial, sympathetic and sacral, represent three largely distinct functions in the economy of the organism. The first has to do with the storing up of reserves of energy for times of need, as is represented in the slowing of the heart beat under stimulation of the cranial connections of the vagus. The second is the great defensive organ through whose activity these reserves are rushed to the front

when needed. This is illustrated by the violent beating of the heart in anger, and by other activities of the organism discussed more fully below. The third has mainly to do with the preservation of the species, and involves the action of the sexual organs.[1]

Dr. Cannon points out that the sympathetic division operates antagonistically and inhibitively in its relation to the other two divisions, stimulating organs which they depress, or *vice versa*. Broadly speaking, it is the more imperious in its demands, and is likely, when in action, to dominate the others.

In connection with the operation of the sympathetic under the influence of pain or great emotional excitement, certain highly interesting glandular effects are observed. Adrenin is secreted and thrown into the circulation by the adrenal glands; additional sugar is also found in the blood. Experiments show that the adrenin is a powerful antidote to fatigue phenomena, and that it tends to drive the blood away from the abdominal organs into the lungs, heart and skeletal muscles, and that under its influence breathing is made deeper. It may be added that with these general conditions blood is found to clot more rapidly than under normal circumstances.

It has of course been a matter of general knowledge for generations that emotional excitement releases resources of muscular energy much in excess of those ordinarily at disposal. Human achievement in battle, in exciting sports, in terror and rage are all instances of this. These researches and others cited in support of the conclusions reached indicate more exactly the mechanisms by which the commonly observed results are actually brought about. Especially do they tend to magnify the office of the adrenal glands, organs whose functions have until recently been shrouded in mystery.

In common with other leading physiologists Dr. Cannon regards the sensation of hunger as due to contractions of the stomach wall in contra-distinction to the other hypotheses in the field; *e. g.*, the theory that hunger is a general bodily sensation, that it is due merely to emptiness of the stomach, that it arises from hydrochloric acid in the empty stomach, etc. The chapter dealing with this topic, while intrinsically interesting, at first sight articulates with the rest of the volume somewhat indirectly. But when the distinction between appetite and hunger is remarked the relevancy of the material to the general theses of the book becomes apparent. Appetite has to do with suggestions of the agreeableness of food, in which sight, taste, smell and the activity of memory are definitely implicated. Hunger is a painful process which often, indeed generally, coincides with appetite, but it may exist without it, or may be wanting when appetite is present. Hunger springs from a definite local source, and involves vigorous action of the sympathetic. Appetite is more definitely psychical, and involves the cranial autonomic rather than the sympathetic. This distinction in the case of hunger and appetite affords a moderate instance of the antagonistic emotional interrelations which are often much more extreme and intense. Dr. Cannon elaborates these antagonisms by exhibiting various emotional expressions in which the sympathetic system is shown acting in vigorous opposition to the cranial and sacral. Perhaps the most striking instance is that of sexual emotion which despite its overwhelming power when once aroused can be inhibited absolutely by such activities of the sympathetic as are represented in fear and anger.

The author annexes as a final chapter to the book a discussion of alternative satisfactions for the fighting instincts and emotions. One is reminded of William James's brilliant paper on the moral equivalents for war. Like James Dr. Cannon concludes that the fighting instincts are too deeply inbred to be speedily exterminated, even if such extermination were thought wise. In order that they may not be perverted nor yet allowed to occasion unlimited human misery, by their normal expression, he advocates athletic competition of all kinds, and especially international games. The issue here

[1] One may suppose that Dr. Canon does not regard as important the suggestions of certain scientists that these organs are in fact largely controlled by plexuses derived from the sympathetic.

raised stands on the whole somewhat apart from the main doctrines of the book and need not be further considered in this place.

Considering the work as a whole, the reviewer has only *one* caveat to offer, and that relates to the critique, both implied and explicit, upon certain features of the James-Lange theory of emotion. Taking Professor James's somewhat playful announcement that we feel afraid because we tremble or run away, a good deal of futile criticism has been expended in attempts to disprove the doctrine. The really significant feature of James's contention has by most of these assaults been left wholly unscathed; *i. e.*, the doctrine that the peculiar modus of emotion, as contrasted with other mental states, was to be found in the dominant part played therein by the reflex elements arising from bodily and especially from visceral sensations. Criticisms such as those of Sherrington and Cannon rest on altogether more substantial foundations than the earlier objections, and deserve more serious consideration. Sherrington has maintained, on the basis of his "spinal dog" that emotion may perfectly well be experienced when all connection of the brain with the viscera is estopped. Dr. Cannon maintains that the visceral agitation is very similar in many otherwise dissimilar emotions, and that in consequence we must abandon hope of finding in visceral sensations any differentia for the various emotions.

Reflexes of the facial and cranial muscles, by which in part at least Sherrington must have judged the presence of emotions in his dogs, are also instinctive and that is really James's important point, not that the reflexes are exclusively visceral. Visceral excitement, especially that of cardiac and respiratory character, undoubtedly often gives emotion its body and bulk. Moreover, even in emotions much alike in many respects and showing many visceral similarities, it is not clear that there are not abundant other differences, extending to the reflex conditions of the general skeletal system, and in no wise directly dependent upon purely cerebral activities. Sickening fear in the face of imminent peril has in it not a little in common with the breathless excitement of the lover about to receive the first kiss of his beloved, but it also has many points of difference. In both there may be a fluttering of the heart and a quickened spasmodic breathing, but in the first there is generally relaxation of the tonus of the entire skeletal system; in the latter instance quite the contrary may be the case, and the skeletal system may be toned to an extremely high pitch.

Until it is shown that consciousness is not characteristically modified in emotion by excitation reflexly aroused whether in skeletal muscles, glandular activities or visceral organs, the main point of James's doctrine will stand firm. Neither Cannon's nor Sherrington's contributions seem to the reviewer to accomplish this.

Dr. Crile's volume, comprising eight addresses delivered from time to time during recent years, is much more loosely integrated than the studies by Dr. Cannon. The essays vary greatly in present value, and connect themselves with the subject of the emotions in very different degrees. One gets the impression that Dr. Crile either is not widely read in modern psychology, or that he attaches very slight value to its literature. Certainly the essay entitled "The Mechanistic View of Psychology" suggests only the slenderest acquaintance with the contemporary views on this issue, and contains, so far as the reviewer has observed, no material not already more forcefully expressed by other writers, especially by Dr. Loeb. In one passage,[2] he says: "Could we dispossess ourselves of the shackles of psychology, forget its confusing nomenclature, and view the human brain, as Sherrington has said, 'as an organ of, and for the adaptation of nervous reaction,' many clinical phenomena would appear in a clearer light." It is not clear what special psychological shackles Dr. Crile is dragging, but the reviewer is at a loss to think of any psychologist of note who would for a moment call in question the formula quoted from Sherrington. Meantime the book, which in portions is over-illustrated with cuts of the kindergarten type, contains a large amount of

[2] P. 48.

admirable material gathered by Dr. Crile and his fellow workers. Much of this is put in fresh and interesting form, but many of the inferences and conclusions based on the facts appear at best quite imperfectly substantiated, and the reader more than once feels the absence of that logical sobriety and reserve which gives Dr. Cannon's book so scientifically satisfactory an atmosphere. Perhaps the most significant facts cited by Dr. Crile are connected with his brilliant surgical experiments on anesthetics and particularly on the use of cocaine to block spinal cord conduction.

In the opening essay on phylogenetic association in medical problems, the main doctrine presented is that racial history has determined the kind of responses made to injurious and threatening stimuli, most of them expressed in emotional activities, and that these resemble in their cerebral cortical consequences the effects of ordinary surgical shock. The latter is found productive of brain injury in ether anesthetization, despite the painlessness of operations under these circumstances; in less degree with nitrous oxide, and to all intents and purposes not at all with his own anoci-association methods of cocaine injection in the spinal cord. Many side issues are touched upon, for example, the phylogenetic history of the struggle between bacteria and their hosts, the history of fear as phylogenetic struggle, etc.

Then follows an address on phylogenetic association in relation to emotion, presenting a doctrine of essentially Darwinian character. Emotion is a vestige of an old and formerly useful act now partially or wholly inhibited and aborted. The author comments suggestively on the alleged fact that animals which have no natural weapons for attack experience neither fear nor anger, while animals which have weapons of attack express anger particularly by energizing the muscles used in attack.

The essay on pain, laughter and crying again evinces either lack of familiarity with, or profound distrust of, the extensive psychological literature dealing with the second phenomenon at least. The doctrine of the protective character of these acts is further developed, and pain is identified as a motor phenomenon with the repeated discharge of brain cells; crying and laughter furnish drainage for dammed up excitation not otherwise conveniently disposable.

The paper entitled "The Relation between the Physical State of Brain Cells and Brain Functions" is an exposition of the doctrine that the cortical cells show most injury in all forms of organic disorder involving the higher mental functions. The essay on the "Mechanistic View of Psychology" has already been referred to.

The essay on the "Mechanistic Theory of Disease" formulates a conception of organic processes which, so far as the reviewer can detect, is substantially identical with that offered by Descartes in 1664.

An address on the "Kinetic System" is a long and rather loosely organized discussion of the thesis that "there is in the body a system evolved primarily for the transformation of latent energy into motion and into heat. This system I propose to designate 'the kinetic system.'"[3] The principal organs of this system are the brain, the thyroid, the adrenals, the liver and the muscles. "The brain is the great central battery which drives the body; the thyroid governs the conditions favoring tissue oxidation; the adrenals govern immediate oxidation processes; the liver fabricates and stores glycogen; and the muscles are the great converters of latent energy into heat and motion." The essay is devoted to a citation of evidence from various sources to substantiate these conceptions, with the constant context that the adaptation of animals to environment involves transformations of energy, in which the organs named are the all important factors.

The final address on alkalescence, acidity and anesthesia is a defense of the doctrine that life depends on the maintenance of normal potential alkalinity and that anesthesia is primarily a function of increasing the acidity of the organism.

The volume as a whole suggests an intelligence of unusual originality and force, somewhat hurriedly and with undue disregard of

[3] P. 174.

the large relevant literature of the subject, dealing with ideas which richly deserve a more leisurely and scholarly development. It is to be hoped that Dr. Crile may in the near future find time for such a treatment.

James R. Angell
The University of Chicago

SPECIAL ARTICLES

A STERILE SIPHON TIP PROTECTOR

The tip of a siphon supplying sterile water, physiological saline solution, or diluent (0.4 per cent. tricresol in 0.85 per cent. NaCl solution) for various bacteriological procedures must be protected from contamination by dust, flies or other unsterile objects. This is accomplished fairly successfully with a bell-shaped cap such as can be made by cutting the bulb of a 50 c.c. volumetric pipette in the middle, leaving attached to each bell a tube 5–7 cm. long for union with the siphon tube, and drawing into this tube by means of a suitably sized rubber hose, another glass tube of such size that when the rubber hose is released its elasticity binds the two together. The covered end of the smaller tube is then adjusted even with that of the bell tube and the rubber hose snipped off, or in fact used to connect to the siphon of the bottle.

But such a device, while giving a fair protection during use, does not prevent the lodgment of upwardly floating particles of lint upon the drop of liquid at the point. It is this protection which the following addition accomplishes.

A test tube about 2.5 cm. × 15 cm. may usually be found to fit outside or inside the bell, as above prepared. The lip is removed and upon the tube is placed a thin rubber finger cot or a finger of a rubber glove from which the closed end has been cut so that the portion which is left may be rolled upon the bell from the tube thus holding the two together and preventing lodgment of contaminating dust when the siphon is out of use. During use the protector may itself be protected by fastening it to another test tube. However, this is scarcely necessary, and I have ordinarily taken no particular precautions to sterilize or prevent contamination of the protector since it touches the bell only and not the siphon tip itself. Yet in certain permissible cases a few drops of formaldehyde in the protector have added a further element of safety.

One of the special purposes to which I have successfully adapted such a device is the frequent examination of bacterial broth cultures being studied for progressive metabolic and morphological changes. For example, some of the fluid from a liquid preparation of *B.*

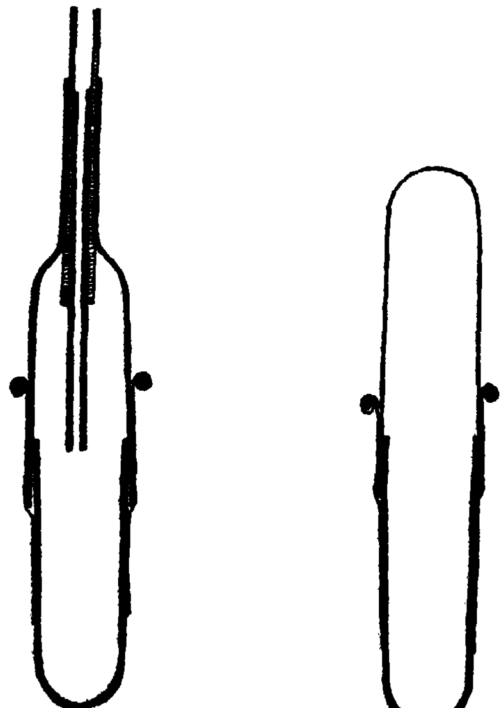


Fig. 1.

diphtheriæ was withdrawn every four days for a period of three weeks, microscopic and cultural examinations made at each withdrawal confirming the continued purity of the contained culture.

Fig. 1 shows a diagrammatic cross section of the apparatus set up (*A*) and taken apart (*B*), for use of the siphon.

Ivan C. Hall
The Cutter Biological Laboratories,
Berkeley, Calif.

SCIENCE

FRIDAY, NOVEMBER 19, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

BIOLOGICAL RESEARCH; THE VALUE AND THE DANGER[1]

I SEIZE with avidity the opportunity furnished me as your retiring president to discuss a subject which I am anxious should have your earnest consideration. I am aware that the title which I have announced is ambiguous, but I think that before I am through there will be no lack of understanding as to what I have in mind. *Biological research* includes many things. I mean to limit myself to those phases of it which require the experimental use of living animals. And I grasp this opportunity because I feel that our colleagues in other fields of scientific effort do not always fully perceive the value of the knowledge attained by this means; and that they do not at all appreciate the danger that freedom of research in these lines may be seriously hampered by hostile legislation or misdirected public opinion.

You who are engaged in very various lines of research will appreciate the fact that the immediate application of a discovery is no fair measure of its value; the ultimate results of the knowledge obtained may become extremely far-reaching. It is in the creation of a background of knowledge and experience that the greatest good is to be obtained. Often we point to certain noteworthy achievements and at the same time fail to perceive that they have become possible only through the accumulation of a multitude of small details, the results attained by the humdrum plodding of patient mediocrity.

The creative imagination of genius is

[1] President's address before the California Chapter of the Sigma Xi, April 28, 1915.

creative, after all, only in the ability to make novel combinations of known elements. The successive steps in the progress of knowledge are absolutely essential. The difference between the genius and the common man is not that the former proceeds by longer steps, but that he takes them more rapidly—often so rapidly that he is hardly himself aware of the intermediate positions.

As an example of the results of the experimental method I want to speak first of the progress of knowledge of the circulatory system—the heart and blood vessels and their mode of functioning.

The beginning of definite scientific knowledge on this subject may be said to date from the publication by William Harvey in 1628, of "De Motu Cordis et Sanguinis," "The Movement of the Heart and Blood."

There was not lacking before the time of Harvey quite complete and accurate knowledge of anatomy of the organs of the circulation; the structure of the heart, the arrangement and distribution of the blood vessels, and the valves of the veins were well known. Notwithstanding this there existed in the minds of anatomists and medical men the most bizarre and remarkable explanations of the uses of these structures. I can perhaps illustrate no better than by a few quotations from Harvey showing the kind of notions against which he had to contend in teaching the doctrine of the circulation of the blood. In the Introduction to "De Motu Cordis et Sanguinis":

> Did the arteries in their diastole take air into their cavities as commonly stated and in their systole emit fuliginous vapors by the same pores of the flesh and skin; and further did they in the time intermediate between the diastole and the systole, contain air, and at all times either air, or spirits or *fuliginous vapors*, what should then be said to Galen, who wrote a book on purpose to show that the arteries contained blood only? . . .
>
> And if the arteries in their systole expel *fuliginous vapors* from their cavities through the pores of the flesh and skin, why not the *spirits*, which are said to be contained in these vessels, at the same time, since spirits are much more subtle than fuliginous vapors, or smoke?

But Harvey, instead of merely *speculating* upon the functions as they might be inferred from appearances in the dead animal, put everything possible to the test of *observation and experiment in the living animal*, and as a result was able to state his reasons for the belief in the circulation of the blood in language which can hardly be improved upon to-day. The different attitude of mind resulting from his practise of observation and experiment is shown in his assertion

> That the facts cognizable by the senses wait upon no opinions, and that the works of nature bow to no antiquity; for indeed there is nothing more ancient or of higher authority than nature.

Contrast with this the views against which he had to strive as shown by another quotation from the same book:

> Medical schools admit three kinds of spirits; the natural spirits flowing through the veins, the vital spirits through the arteries, and the animal spirits through the nerves. . . .
>
> Farther, besides the three orders of influxive spirits adverted to, a like number of inplanted or stationary spirits seem to be acknowledged; but we have found none of these spirits by dissection, neither in the veins, nerves, arteries, nor other parts of living animals.

It was never permitted Harvey to know the exact method by which the blood passed from the terminations of the arteries to the beginnings of the veins; for no microscope suitable for the observation of the capillaries had then been invented. This final step was reached by Malpighi in 1661 just four years after Harvey's death.

After the *fact* of the circulation had been established, it began to be possible to investigate the mode of working of the circulatory apparatus. The first important step in this direction was taken by the Reverend

Stephen Hales, a Church of England clergyman, who tied into the femoral artery of the horse a glass tube nine feet high and noted the height to which the blood rose. He was able to report an average pressure of the blood in the artery sufficient to support a column of liquid eight feet three inches in height, while the blood rose at the same time to less than one foot in the corresponding vein. He observed also fluctuations in pressure due to the individual heart beats, to the movements of respiration and to other causes. The details of his experiments were communicated to the Royal Society of which he was a fellow and were published in 1733 in a work entitled "Statical Essays, Containing Haemostaticks."

The method employed by Hales was extremely inconvenient on account of height of the tube. Moreover, it introduced a greatly disturbing factor, namely, the loss of blood from the vessels of the animal into the tube. These inconveniences were overcome by the use of the mercury manometer by Poiseuille (in 1828). But the careful and detailed study of blood pressure dates from the invention by Ludwig (1847) of an exact method of recording blood pressures. From that time onward, not only in Ludwig's laboratory where many of the generation of physiologists just passing were trained in the methods of their science, but in all the physiological laboratories of the world has the study of blood pressure been continued.

It is impossible here to summarize all the facts of importance that have been the outgrowth of these investigations, and of others, connected with the functions of the circulatory system, and which could have been learned in no other way than by experiments on living animals.

The heart is a pump driving an incompressible liquid through a completely closed system of branching elastic tubes, the terminal connections of the outflow and inflow portions of the system being all of capillary size. The study of this system presents a series of difficult problems in *hydrodynamics*, in which all the relations of force, rate and output of the pump, the heart, and the pressure, and friction conditions in the arteries, veins and capillaries must be considered.

But this machinery is all composed of living tissues which are interacting and self regulatory to an extraordinary degree.

The discovery by Claude Bernard, and others, of the existence of vasomotor nerves through which the caliber of the arteries may be changed, regulated and controlled, thus adjusting the resistance to the ability of the heart, and also providing that the heavier flow of blood may be shunted from one set of organs to another according to the needs of the body, is of prime importance; so also was the discovery by Weber of the inhibitory action of the vagus nerve upon the heart, which, acting like a brake on that organ, keeps its action always under definite control; and the discovery by v. Cyon of the accelerator nerves whose function is in direct opposition to that of the vagus. Further, v. Cyon found that a special nerve, the depressor, carrying impulses from the heart and the great blood vessels to the brain, causes, when excited, a dilatation of the peripheral vessels and consequent reduction of the pressure against which the heart must work. None of these things could have been guessed from the study of the anatomical structures, nor could ever have been found out in any other possible way than by experiments on living animals.

But it may be asked, Has this knowledge any value? Has it any practical application? Is it useful only for the gratification of mere curiosity?

Putting aside for the present the implication in the expression "mere curiosity" which we hear so often in this connection I may answer that it is now possible to measure the blood pressure in man without resort to the method of Hales; no blood vessel has to be opened and no pain has to be inflicted. Blood pressure determination forms a part of every examination for life insurance, and of the routine of nearly every present-day medical examination. In certain conditions its measurement is of the most extreme importance. It gives exact, quantitative information on the state of the heart and blood vessels that could be obtained in no other way. And the usefulness of this information so far from being confined to diagnosis of disease of these organs themselves is quite as important in the light it throws on the functioning of other organs.

I have given this rather disproportionately long statement of the physiology of the circulation to make very specific what I mean in saying that the importance of most investigations is to be found not in the direct application of the specific discoveries but in the reflex effect of these on all related work. Antivivisectionists use the knowledge which has been obtained by experiments on living animals. No modern physician can for a single hour free himself from the deepest obligation to vivisection experiments, although he may never himself have made such experiments.

It is quite true that human blood pressure may now be determined without opening an artery and that the principles may now be explained without appeal to animal experiments; but I believe it to be equally true that this would not now be possible, and that neither the method of blood pressure determination nor its significance would now be known if the long series of vivisections had not first occurred.

In this connection it will be appropriate to say a word about surgical shock. Every one realizes that as surgery is practised today the chance of coming out of a major surgical operation is always good, yet it is no light matter; there is usually real danger; and the memory still remains with us of friends or acquaintances who in an otherwise not serious operation succumbed to shock. Shock is a peculiar complex not easy to define. There is not usually the suddenness which the word implies to the lay mind; but there is a great depression of the functional activities; and most marked of all its symptoms is an excessive fall of blood pressure. To discover the real nature of shock and thus to furnish the surgeon the means of its avoidance is no small boon to humanity. With this purpose in view many researches have been carried on. It has not been easy to find the true cause of the lowered blood pressure but much progress has been made. Perhaps no one man has made such untiring efforts to the solution of this problem as George W. Crile, and for this he has been denominated "brute," "savage," "arch fiend," "torturer" and almost every other term which fanaticism can devise. And yet it is to Crile and the system of *anoci-association* which he has worked out that every man or woman who has to undergo a major surgical operation owes a debt of gratitude which he can never repay; for not only does this method, where applicable, reduce the immediate danger from surgical shock, but it also greatly reduces or wholly sets aside the long period of nervous impairment which so commonly follows recovery from an operation in which these principles are disregarded.

I have selected the history of the study of blood pressure on account of its comparative freedom from those details which appeal to the emotional and dramatic side of human nature. I have used it to illus-

trate the growth of knowledge sought for its own sake into knowledge which is applied to the good of man. But I have merely touched upon the latter. Let me emphasize again that the great importance is not in the value of this or that specific detail, but in the great background which has been built up, which enables us to gain and to interpret new knowledge, and to see things in a proper perspective.

The physiology of digestion might have served equally well to illustrate the same truths. We owe to Pawlow and other workers in this line a mass of knowledge of prime importance to man, and this could not have been obtained in any other way than by vivisection. It is true that a few unfortunate human beings have had gastric fistulas formed through accident, and they have been used to study processes going on in the living stomach. But these studies have had no such orderliness as those in which upon animals definitely planned and controllable operations have been made. Indeed, the human observations have been mainly useful to check up the observations on animals and to see whether for some reason conclusions drawn from animals might not be wholly applicable to man.

To experiments on living animals we owe most of what is known of the functions of the various parts of the nervous system. The possibility of diagnosis of the seat of nerve tumors, of injuries, of pressure due to blood-clot and the like, in many instances depends upon knowledge of cerebral localization first discovered by experiment on the brain of the dog.

We are just now at the entrance into a new era in the history of physiological science. The study of the glands of internal secretion is widening and deepening our vision of the life processes, and I confidently believe that the next decade or two will be most fruitful in this comparatively new field of research. Already we have use of adrenalin, and various gland extracts. Nearly all our knowledge is based on vivisection.

It is not the purpose of this paper to go into the enumeration of specific instances of the *value* of biological research; many of them are already familiar; some of them are, rightly considered, among the greatest achievements of the human race. You know that the event celebrated by the great Exposition whose lights are at this moment blazing across the Bay could not have been accomplished if malaria had not first been conquered through biological research; you know that Havana by the same means has been changed from a seed bed of yellow fever to a healthy port and has ceased to be a menace to our own southern coast. You know that while occasional deaths from diphtheria still occur, the intelligent use of antitoxin has dispelled the dread and the terror which its presence in any community formerly produced; that a knowledge of the Pasteur treatment for rabies has reduced the death rate from that horrible disease from 15 per cent. to about 0.3 of 1 per cent. These and the like achievements are what the Hon. Stephen Coleridge, president of the English Antivivisection organization has eloquently denominated *"The desolating advance of science."*

You know all these things and much more, of the *value* of the achievements of biological research. But you probably do not know or, knowing, do not realize the vigor of opposition to all this effort for the advance of knowledge and the good of humanity. The *danger* of limiting, harmful restrictions is imminent and absolute prohibition is not improbable.

In England for years it has been necessary, if one wishes to perform a single vivisection experiment, to procure a license. It

is much easier to get a license to run a low grogshop. Any man may without a license and with practically no regard for the sensations of the animals rip out the testes from a boar or a dog, merely because it suits his convenience or his whim or his purse to have his animals gelded; but if a physiologist wishes to make the same operation for the purpose of scientific observation on the effects of castration he must secure a license stating with precision the building where this is to be done, and the purpose of the experiment, and he MUST, he has no option, perform the operation under complete anesthesia.

In this country at present the opponents of biological research point to England as the model country. But in England they continue the agitation for further regulation or complete prohibition, and they continue to persecute the licensees with persistent vilification and misrepresentation.

It would be out of place for me to take your time in a statement of the peculiarly extravagant and unscientific views of the opponents of biological and medical research if it were not that there is a real danger of the enactment of pernicious and obstructive legislation. A situation exists in which we who are doing what we believe to be an important work for humanity need your active cooperation, sympathy and support.

1. Practically all antivisectionists agree in the charge that experiments on living animals are necessarily cruel.

Now cruelty implies the infliction of needless or avoidable pain. No one justifies or can justify cruelty in experimentation any more than he can justify cruelty in any other action. But in the question of pain the unbiased individual will see that no one is so well qualified to judge as the experienced physiologist or surgeon. It would require the whole evening to discuss this one subject. Allow me to point out in brief the following:

The experimenter, even if he were really cruel, would usually defeat his own ends by the infliction of pain (*a*) because the pain impulses would cause disturbance of the normal functions which he seeks to discover and (*b*) because the struggles of a suffering animal would disturb the adjustment of apparatus and prevent the desired observation. It is the total ignorance of the real situation that causes so much emphasis to be laid upon this point by the opponents of research.

On the other hand, it is the fact that most vivisection experiments as actually performed, are done under deep anesthesia or narcosis—usually for obvious reasons much deeper than would dare be employed in human surgery. Now the opponents of research insist that anesthetics are not given, or that when given the attempt at anesthesia is a mere blind, and that the animals are allowed to undergo torture. Most of this discussion is by people who never gave an anesthetic, who would not know when an animal could be judged unconscious, and who would be unable to form an intelligent opinion as to whether movements of the animal were unconscious reflexes or purposeful struggles.

But why assume, as every one of the antivivisectionists does seem to assume, that all persons engaged in animal experimentation are necessarily cruel? As one reads their publications he finds that always the experimenter is supposed to delight in torture. In fact he is spoken of over and over again as "arch-fiend," "torturer," "devil in human form" and the like. Can they see no other purpose? No other motive? Has the eminent head of our department of pathology exposed himself week after week to the danger of infection with typhoid, tuberculosis and what not, merely because

he has a fiendish delight in seeing the quivering of flesh and hearing the plaintive squeal of guinea-pigs when he thrusts the hypodermic into them? Why would not a plain needle serve equally? The point of view is so absurd that it should require no discussion among intelligent people.

It is charged, however, that the practise of vivisection tends to induce a disregard for the sufferings of animals and brutalizes the mind and conduct of the experimenter. Now it happens that I have a pretty wide acquaintance among physiologists, and I have known some of the most accused vivisectors rather intimately. Of course they are not all alike, they differ as other men differ. But on the average in point of humane, kindly sympathy they stand above their colleagues. And the reason for this is clear to him who will listen to reason. They have gone into this work because the higher human sympathy has appealed to them; they have sought earnestly for those things which will relieve or prevent suffering; their lives are given to the solution of problems the ultimate end of which is found in the very things about which they are charged to be wholly indifferent.

Not only is it not true that vivisection experiments tend to make the experimenter callous; the reverse is actually the case. I can testify from my own experience that it is harder to make the fiftieth experiment than the first; that one's sympathies are more and more awakened rather than destroyed. There is no doubt that abuses are possible—are even probable. Yet most of the stories told to illustrate the brutality of vivisectors in things aside from the experiments themselves are highly improbable. As, for example, the statement that Dr. Sweet, of the University of Pennsylvania, kicked across the basement floor a poor emaciated dog on which he had operated. An operated animal is too valuable to be used in this way.

Were I to descend to the methods of our detractors I might use the following from my own experience to prove that antivivisection doctrine induces brutality.

I was once teaching in a small college the president of which was an ardent antivivisectionist. One day I received by mail a large poisonous centipede, carelessly enclosed in an unlabeled box. I made haste to get it into a wide-mouthed bottle. I had just succeeded when the president came into the room followed by a stray dog. There was a rule that dogs were not to be allowed in these rooms. The president took me roughly to task for allowing the poor centipede to suffer for lack of air in the bottle. Then, seeing the dog, he asked if it was mine? When I told him it was not he ordered it out of the room. The poor animal instead of obeying crouched on the floor and the president kicked it brutally and cruelly across the room and through the entance. Yet he could declaim with tearful voice upon Llewellyn's faithful hound Gelert!

It should be emphasized here that the lower animals themselves gain immensely from the results of vivisection and of experiments on living animals. The same advantages of protective serums and antitoxins are made available for them as for the human. The Agriculture Department of the University of California at the present time makes and distributes hog cholera serum. The Report of the College of Agriculture for the year 1913–14 states that when a herd of hogs becomes infected and is not treated with serum forty to eighty per cent. of the animals die. I am told by experienced and unprejudiced stock raisers that this estimate errs on the side of conservatism. The report shows further the following figures for a diseased herd treated with the serum:

Died before vaccination	92
Sick when vaccinated	123

Number vaccinated	1,656
Died after vaccination	233
Per cent. of loss	19

That is the conservative statement of the report. There should actually be deducted the 123 sick when vaccinated, for vaccination does not help those aleady sick with the disease. That reduces the percentage to 15 as compared with 40 to 80 per cent. when unvaccinated.

Now the vaccine can not be prepared without operation on living animals; and the method and the underlying idea could never have been reached except through animal experimentation.

This may serve as a near-by example of what is done and as a forecast of what will be done for the animals themselves. The very beginning of Pasteur's famous work was for the conservation of animal health. *To this really great end none of the opponents of vivisection has contributed an iota.*

2. It is affirmed by most antivivisectionists that experiments on animals are useless in that no knowledge of any real value has ever been attained in that way. This attitude is well illustrated in a recent circular entitled "Claim Everything" issued by the American Antivivisection Society. This circular is intended to be a rebuttal to an article by Dr. W. W. Keen in the *Scientific American* of June 20, 1914. The statements in the circular are on the authority of the president of the British Union for the Abolition of Vivisection. The circular says,

> Brain surgery owes nothing to animal experimentation. In brain, above all, the animal differs from man.

This appeals to a multitude of voters who do not know that motor localization was discovered by Fritsch and Hitzig on the brain of a dog. Dr. Keen had referred to the new and highly successful methods of direct transfusion of blood. The circular states,

> The direct transfusion of blood needs no experiments with animals, nor is the operation itself necessary.

The curious psychological twist in the reasoning of the opponents of progress in scientific medicine is shown in the following quotations from the same circular, copied verbatim, except that to save the space of comment I have inserted the italics:

> Operations for goiter, again, depend upon the *aseptic treatment.*
>
> Diphtheria has been reduced solely by *sanitary measures.*
>
> Malaria has been abolished by *sanitation.*
>
> Yellow fever can not have been abolished by any means based on experiments on animals, *because the germ has never been found* to experiment with.
>
> Discovery of salvarsan. This had better never have been made.

Every one familiar with the history of hygiene and sanitation knows how much of our knowledge and our point of view has been obtained through experiments on animals. Prohibit animal experimentation and progress in hygiene and sanitation would be practically brought to a standstill. Yet the opponents of research reiterate the statement that hygiene and not experimentation has enabled us to advance, and hence that experimentation is useless. Where a forward step has been made which is not attributable to "hygiene," as in the case of direct blood transfusion, its usefulness is flatly denied.

In most literature of this kind you will find expressed or implied a denial of the whole range of scientific knowledge as to the relation of microbes to disease. They refer to serums, vaccines and antitoxins in terms of profound contempt. A favorite expression is one which I have heard used by a California legislator, who calls vaccine "rotten animal pus" and who would make it a criminal offense to introduce any vaccine into the human system.

3. *Another argument is based on the so-called "rights of animals."* As a question of theoretical ethics I am willing to leave that for the present to the philosophers. I can not argue with the man who insists that his dog and his hog are as good as he is; that he has no right to restrain the one or to eat the other. If he refuse to eat meat, or eggs, drink milk, use leather, wool or other animal products for clothing or shelter; if he refuse to make counter attacks against the lions or serpents which attack him, he is consistent; I can not argue with him; I can merely watch him go his way in the procession with the trilobite, the ichthyosaurus and the dodo. But intensely practical questions arise and must be met. And the life of a relatively few animals is placed against the life and health and comfort of the human race. The antivivisectionist insists that even if you grant that the injury to the guinea-pig or the rabbit or the horse will save the life of a child you have no right to save it in that way. If there is not room in the life-boat for the woman and the dog you have no right to push out the dog to make room for the woman.

But here I want to take issue squarely with the claim that we have no right to make experiments which cause pain—that is a fatal admission which some of the English physiologists have made. We have a right to perform painful experiments if the knowledge that we seek can be obtained in no other way. Ordinarily it can be obtained better without pain, or can only be obtained in the absence of pain, but the principle remains. So long as man lives in the same world with other animals, eating to some extent the same food, subject to a large extent to the same diseases, it will be necessary for man either to maintain the mastery or to become one of the beasts of the field himself.

But especially I can not see why experiments for the good of humanity and for the benefit of the animals themselves should be prohibited on the ground of cruelty and the absence of right, in the light of the permission of many other things. The castration of an animal as performed on the farm by far exceeds in cruelty and callousness of performance anything which I have ever witnessed in a laboratory. A few hundred animals are used in all our laboratories for all purposes. The census report shows that in California in 1909, there were born 163,728 bull calves. It is fair to assume that 150,000 were castrated. There were born 41,927 colts. Of these approximately one half were probably males, and making deductions for those kept as stallions, there were here at the lowest estimate 19,000 geldings. There were 283,741 pigs born, which means probably 135,000 males to have their testes ripped out. A total each year in California of 304,000 operations. Comparing these in number and violence with the work in biological laboratories and medical schools, the latter becomes wholly insignificant. But the gelding of the boar does not have the emotional appeal in it and we hear little about it. Dehorning of cattle is a painful operation, but it saves vastly more pain which would result from the injury which, without it, they would inflict upon one another.

4. It is urged that certain results of undoubted value (or from the standpoint of the opponents of research, of possible value) could have been reached by some other way. This is a line of reasoning which has been used with a great flourish of apparent candor and show of plausibility. A biologist having by a long and painstaking series of experiments found the solution of a problem, a pettifogger takes that solution and shows by a play on words, how he could, without experiment, have de-

rived the same conclusion from certain given data. This is the basis of the constant appeal to hygiene, as the means of prevention of disease; while the very principles of hygiene are based throughout on animal experimentation.

I have read recently with great interest two books, accounts of journeys over practically the same ground, the journey from Mombasa on the East African coast to the great lakes at the source of the Nile. The one is by Lieutenant Speke, the other by Colonel Roosevelt. Speke traveled in constant danger and discomfort, beset with discouragements and the opposition of treacherous natives, in an unexplored, unknown land. Roosevelt made the trip by railroad. Our antivivisection opponents continually upbraid us for traveling like Speke in the difficult, uncharted territory, when we might wait and go *de luxe* in a Pullman: Will *they* build the road while *we* wait?

5. A further charge is urged against vivisection, that it leads to a state of mind which will not hesitate to make similar experiments on man. Human vivisection is held up as the acme of the fiendish impulses of the biologist, physiologist or surgeon. A hospital is a place of unspeakable horrors.

Now on this I must make two remarks. (1) That any thinking man will see that certain observations may be made on a patient without injury or pain to the patient, and that if these observations or experiments furnish useful knowledge, there can be no possible objection to them, and (2) every surgical operation is a vivisection experiment in one sense. A surgical friend has vivisected me, and yet I do not call him a fiend and an arch torturer.

Of course there are all sorts of men among physicians and surgeons as in all other professions. Abuses and outrages do occur, no doubt. There have been wicked doctors who have abused their trust; and there have been clergymen with whom the virtue of a young lady boarder was not safe; but we need not say for this reason that all surgeons are arch torturers and that all preachers are arch-lechers.

And this brings me to a point I wish to insist upon, that just as you do not need to pass a special law against adultery by ministers of the gospel, but that if you did so you would put an imputation on the character of a large body of earnest, sincere and unselfish men, so you should not pass laws which would put on men in biological research the imputation of bad faith and cruelty. Make the general laws against cruelty to animals as strict and far-reaching as may seem necessary for the good of the human race; but do not single out the men who are devoting their lives to the search after that knowledge which is for the best good of the race, and make them the special objects of unnecessary, restrictive limitations. If experiments on animals must be prohibited let the same law prohibit castration of animals and the dehorning of cattle. If the English law requiring all operations by a scientific man to be done under anesthesia be adopted, then require that the operations on the farm be performed in the same way.

You will perhaps say that the arguments mentioned are unworthy of attention; that it is beneath our dignity to answer them. It will not do to take that attitude. The opponents of research are too strong and too well organized to be neglected. They have enormous sums of money at their disposal. They have been able to subsidize newspapers and are prepared for a campaign of persecution and prosecution. The opponents of research are not easy to classify. They represent widely varied types of mind, but the following are usually recognizable:

1. The fanatics. This type is represented by the man who states over his signature that he would prefer to have his own child die of diphtheria than to have it saved by the torture (?) of a single guinea-pig. These are perhaps the only thoroughly consistent antivivisectionists. They are often so much in earnest that they do not hesitate to mislead the public through publication of untruths.

2. The cultured ignoramuses. A large class of people highly educated along certain lines of language and literature, but profoundly ignorant of the most simple and fundamental facts of natural law. They are the Clara Vere de Veres of both sexes and all ages.

3. The financially interested. Great fortunes are accumulated by the sale of patent nostrums. The business makes headway in proportion as medical knowledge and medical practise can be thrown into disrepute. Thus the *Journal of Zoophily*, January, 1915, quotes the following with no word of disapproval.

Medical Freedom says in its October number:

"Only recently Mrs. Catherine E. Mercer and her two children were vaccinated against typhoid in Brooklyn, N. Y. All were made ill. Mrs. Mercer died and the two children suffered for weeks. In Iowa a perfectly healthy guardsman was vaccinated against typhoid, became ill and died. In Camp Dodge, Des Moines, Iowa, Conrad Liljeberg died soon after vaccination. Also Clarence Pantzer, Thirteenth Coast Artillery, National Guard, New York."

4. Religious cults. It must be said to the credit of the majority of those who profess a religious philosophy which ignores disease that they are not inclined to put obstacles in the way of medical progress. Nevertheless, in a recent number of the *Journal of Zoophily*, a column headed Anti-Vivisection Notes is entirely occupied by a long tirade against the medical profession by the senior senator from California.

5. Demagogues. These are not wanting and in California have been not unsuccessful in securing legislative position by masquerading as benefactors and reformers.

The above are strange bedfellows, but they seem to agree well among themselves. They have this more or less in common that they desire to throw the efforts of the earnest, honest physician into disrepute; his loss is their gain. Anything does for a pretext. It can be vivisection or vaccination or quarantine or what not. Their method is always that of the pettifogger or the demagogue. They publish accounts of experiments done under anesthesia and of experiments done before the introduction of anesthetics as if they were all alike and now all in vogue. They describe vivisections done in the days when men were hanged and quartered as if they were the common practise of to-day. And in it all the appeal is to sentiment and prejudice, not to reason and common sense. By these methods they reach and may yet more effectively influence large numbers of honest and conscientious voters too busy to inform themselves as to the real issues, and unable to unravel the tangle of sophistry, sentiment and misrepresentation, with the result that there is great danger of hostile and harmful legislation.

In the face of all this opposition I feel justified in calling for support from you who are working in the various fields of science more or less remote to that of biology, not only because as co-workers in the effort to enlarge the sphere of human knowledge as men of open mind and enlightened sympathies your support may rightly be expected by those whose researches are primarily concerned in the discovery of those truths that are directly applicable to the diminution of pain and suffering and disease. But I would also place before you the importance to all of

you in your various fields of that which I have called the larger background of knowledge. It is only by this that we can see things in their true perspective. Our respective sciences and our special fields of research become of value only when their wider relations are apprehended. And may I without unduly magnifying mine office as a biologist call your attention to the fact that biology has contributed no unworthy share to the means of progress in the sister sciences. The contributions of biologists, especially the workers in physiological chemistry, to the general advance of chemical science does not require to be mentioned; nor do I need to refer to the usefulness to physical chemistry of the fertile ideas of Pfeffer and De Vries in the explanation of osmotic pressure. The physicists do not need to be told that by far the most sensitive galvanometer for the measurement of minute currents of short duration is the device of the physiologist Einthoven, designed primarily for use in the study of living organs. The engineers will recall that the method of recording progressive changes on a revolving drum is the application of the kymographion invented by Ludwig for the recording of blood pressures; but now employed in securing graphic records of a great variety of natural phenomena.

Or let me reverse the picture and remind you that the physiologist, the pathologist and the physician are laboring to apply the results of your researches in the explanation of the normal life processes, and to use them in the discovery of the causes of pain and suffering and disease, to the end that these causes may be overcome. Toward this result all lines of scientific effort are contributory.

SAMUEL S. MAXWELL
UNIVERSITY OF CALIFORNIA

THE ERRORS IN PRECISE LEVELING DUE TO IRREGULAR ATMOSPHERIC REFRACTIONS[1]

VERY accurate determinations of elevations above some datum have been made possible by the great improvements in the wye or spirit level which have taken place during the last half century. In 1867 the International Geodetic Association defined precise leveling as that which has a probable accidental error of not more than 3 mm. per kilometer. The leveling run to establish the controlling or fundamental elevations in the interior of the countries, during the decades which followed, showed these limits to be too liberal. In 1912 the International Geodetic Association adopted a resolution calling for a still higher grade of leveling called "leveling of high precision." This is defined as leveling in which every line, set of lines or net is run twice in opposite directions on different dates, as far as possible, and whose errors, computed by prescribed formulas, do not exceed ± 1 mm. per kilometer for the probable accidental error and ± 0.2 mm. per kilometer for the probable systematic error.

This class of leveling is easily secured with the modern instruments and methods. In fact the greater portion of the leveling done with the older instruments and methods in the United States by the Coast and Geodetic Survey and by other organizations came within these limits.

The datum or plane of reference which has been adopted in this and in other countries is mean sea level, that is the surface of the oceans with the water assumed to be at rest and affected only by gravity. This surface may be determined with relation to fixed points on land by long series of tidal observations. The mean surface varies in height from day to day, month to month, and even from year to year. Whether there are secular changes is not definitely known. The disturbing influences are the sun and moon, prevailing winds and varying atmospheric pressures. The configuration of the shore may have some

[1] Read before the Washington Philosophical Society, March 13, 1915.

effect, but this would probably be very slight at points on the open coast and would no doubt be constant and not show in the series of tidal results.

The following table gives the yearly averages for the tidal stations at the Presidio, San Francisco, just inside the Golden Gate.

Year	Height, Ft.	Year	Height, Ft.	Year	Height, Ft.	Year	Height, Ft.
1898	8.30	1902	8.57	1906	8.58	1910	8.42
1899	8.44	1903	8.53	1907	8.66	1911	8.61
1900	8.50	1904	8.63	1908	8.43	1912	8.49
1901	8.46	1905	8.65	1909	8.53	1913	8.51

The mean sea level for 16 years (1898 to 1913) equals 8.519 feet on the staff. The staff was frequently referred to a substantial bench mark near the tidal station and corrections were applied to take account of any variation in the elevation of the zero of the staff referred to this bench mark.

The total range during the 16 years was 0.36 foot. The greatest difference from the mean is 0.22 foot, while the average difference is 0.075 foot. It is seen that the mean value for any three consecutive years does not differ from the mean for the sixteen years by more than .110 foot. There are 14 3-year groups with an average difference from the mean of 0.04 foot, about 1.3 centimeters.

Ordinarily when a tidal station is established solely for determining mean sea level from which to extend a line of precise levels a series of tidal observations extending through only three years is made. Judging from the San Francisco records, we may therefore expect an uncertainty of the plane of 0.04 foot or 0.013 meter.

Whether or not the mean sea levels at different parts of the same ocean and of different oceans lie in the same equipotential surface is a question which has not been solved in the United States. It is true that the several transcontinental lines of levels indicate that the Pacific is higher than the Atlantic and Gulf, but this may be due to accumulated errors in the thousands of miles of levels involved. The results of careful leveling across the Isthmus of Panama show that the mean sea levels of the Atlantic and Pacific are in the same equipotential surface within 17.8 centimeters. This difference may be largely due to the unavoidable errors in the leveling and the determination of the sea levels of the two oceans. The mean sea level on the Pacific was determined by observations through only one year and may be in error several tenths of a foot.

The leveling across Florida is not strong and its results are not conclusive. There are four lines between St. Augustine on the Atlantic and Cedar Keys on the Gulf, with a total range of 0.85 meter in the difference in elevation of the two places. At each of those points tidal observations are being made and within a year or two a new line of levels will be run between them. We hope to obtain then some definite data in regard to the relative elevations of the two bodies of water.

In the absence of conclusive information we have assumed in our level net adjustment that the surfaces of the three great bodies of water touching this country are in the same equipotential surface and the starting points of the various lines of levels are consequently given zero elevations.

There are two ways in which the errors of leveling show; one in the closing of circuits, and the other in the disagreement in the difference in elevation between each two consecutive bench marks as determined by the two runnings of the line between them. We shall not have time to consider at length the closing errors. The closing errors of the circuits of levels run entirely with the new instruments and methods[2] are seldom greater than 0.20 millimeter per kilometer. This is a clear indication that the accumulative errors in a long line are small.

The following table shows the principal facts in regard to the closing errors of the 84 circuits forming the net which was adjusted in 1912.

There are many sources of error in leveling, of a systematic nature which may be made to

[2] See the following C. and G. S. publications: Appendix No. 3, Report for 1903, and Special Publications Nos. 18 and 22.

Rate per Km. in Mm.	Rate per Mile in Thousandths of Foot	No. of Lines	No. Km.	No. Miles	Per Cent. of Whole
.00 to .10	0.00 to 0.52	56	17,251	10,719	40.1
.10 " .20	0.52 " 1.05	36	8,708	5,411	20.3
.20 " .30	1.05 " 1.57	30	9,732	6,047	22.6
.30 " .40	1.57 " 2.10	7	1,480	920	3.4
.40 " .50	2.10 " 2.62	14	1,488	925	3.5
.50 " .60	2.62 " 3.15	4	492	306	1.1
.60 " .70	3.15 " 3.67	5	595	370	1.4
.70 " .80	3.67 " 4.20	1	312	194	0.7
.80 " .90	4.20 " 4.72	1	150	93	0.3
.90 " 1.00	4.72 " 5.25	5	647	402	1.5
1.00 " 2.00	5.25 " 10.50	13	2,076	1,290	4.8
Over 2.00	Over 10.50	1	48	30	0.1
		173	42,979	26,707	99.8

act as accidental errors in a long line of levels. The methods followed in the Coast and Geodetic Survey have this in view. One of the most troublesome errors encountered in the past was due to the changes in the relation between the line of sight and the axis of the bubble caused by rapid and unequal temperature changes in the different parts of the instrument. The older instruments were made of metals having large coefficients of expansion, and the bubble was at a considerable distance from the center of the telescope tube. It was found that the error of a line was a function of its direction or azimuth. This error is probably eliminated in leveling run with the Coast and Geodetic Survey level which has been in use about fifteen years. It is made of nickel-iron with a coefficient of expansion of only .000004 and its bubble is set into the tube of the telescope near the line of sight.

We will not consider the sources of errors which are well known and which are largely eliminated by the methods employed, but will confine ourselves to some interesting errors apparently due to variations in the vertical atmospheric refraction on steep grades, and even these can only be touched upon. They are considered at some length in a recent publication of the Survey.[3]

All leveling by the Survey is run in both directions, forward and backward, the line is divided into sections approximately one kilometer in length, and the two runnings of a section are made in different days in order to vary the atmospheric conditions. Usually one running is made in the morning and the other in the afternoon. For a number of years the observers have kept records of the time of day of the runnings of the different sections and the weather conditions which obtained. Five lines of levels were selected for a study of the possible relation between the errors of leveling and the conditions of the weather, the time of the observations and the steepness of the grade. These lines are:

No.	Line	Distance, Kms.	Direction of Progress	Average Length of Section, Kms.
1	San Francisco, Cal. to Marmol, Nev.	497	Eastward	0.8
2	Beowawe to Marmol, Nev.	451	Westward	0.9
3	Brigham, Utah, to Beowawe, Nev......	486	do.	0.8
4	Butte to Devon, Mont.	461	Northward	0.8
5	Pocatello, Idaho, to Butte, Mont.........	415	do.	1.1
	Total..............	2310		

Mean grade per section, steep slopes. 16.6 meters
Mean grade per section, low slopes... 3.4 meters
Mean grade per section, all sections... 6.4 meters

The total length of these lines is 2,310 kilometers. As it was impracticable to investigate the relations between the size and sign of the discrepancy between the results of the two runnings of the sections and the many different grades, the leveling was separated into only two classes: First, those having grades exceeding ten meters and, second, those with smaller grades. As the average length of a section is about one kilometer a ten-meter grade corresponds to a grade of approximately one per cent. The average grade for the first class is 16.6 meters, for the second 3.4 meters, and for all the sections 6.4 meters.

We shall first see whether there is any difference in the elevation between the two ends of a section by the two runnings where one running is in the morning and the other in the afternoon. The direction of the slope is not considered. In the following table A

[3] See Special Publication No. 22, of the C. and G. Survey.

stands for the morning and *P* for the afternoon running. The discrepancies are given in millimeters.

MORNING AND AFTERNOON RUNNINGS COMPARED, WEATHER CONDITIONS IGNORED

	Steep Grade	Low Grade
Number of sections	188	761
P–A, total, positive	+ 496.4	+ 1,645.1
Mean discrepancy	+ 2.64	+ 2.16
Number of sections	144	629
P–A, total, negative	— 340.4	— 1,277.8
Mean discrepancy	— 2.36	— 2.03
Number of sections	332	1,390
Mean discrepancy	2.52	2.10
Accumulated discrepancy	+ 156.0	+ 367.3
Mean accumulation per section	+ 0.47	+ 0.26

For both classes the sections with positive values of *P–A* predominate while the mean accumulated discrepancy per section for the low grades is only 0.55 of that for the steep grades.

The next table includes the morning and afternoon runnings, which were made in sunshine.

MORNING AND AFTERNOON RUNNINGS, ALL IN SUNSHINE

	Steep Grade	Low Grade
Number of sections	131	529
P–A, total, positive	+ 358.6	+ 1,140.8
Mean discrepancy	+ 2.74	+ 2.15
Number of sections	87	456
P–A, total, negative	— 203.0	— 935.5
Mean discrepancy	— 2.33	— 2.05
Number of sections	218	985
Mean discrepancy	2.58	2.11
Accumulated discrepancy	+ 155.6	+ 205.3
Mean discrepancy per section	+ 0.71	+ 0.21

The evidence here is similar to that of the preceding table but the accumulated discrepancy for the steep grades is three and one half times as great as that for the lower grades.

The investigation does not indicate whether the morning or the afternoon running gives a value nearer the truth, but it is the speaker's opinion that the afternoon is freer from error than the morning running.

It is the speaker's opinion that the afternoon running gives on an average a difference which is closer to the truth than the morning running. In the afternoon the temperatures of the ground and of the air are more nearly the same and a layer of air of uniform density should be concentric or nearly so with the sea-level surface. If this is true the refraction on the front and back sights should be about the same. The leveling of the U. S. Coast and Geodetic Survey is seldom done after 5 o'clock in the afternoon. So the afternoon running is not materially affected by the abnormal refraction of the late afternoon when a line of sight on a grade would pass through layers of colder and denser air which would tend to be concentric with the surface of the ground. In the late afternoon the earth cools more rapidly than the air and the air near the earth's surface becomes colder than the air above and consequently denser than normal.

In the morning on a clear day the air is receiving radiated heat from the earth's surface. This decreases the density of the air close to the ground, and forms layers which tend to be concentric with the surface of the ground rather than with the sea level surface. (The air near the earth is of course not at rest but tends to rise, owing to the decreased density.) It may be assumed that the line of sight to the observer from the rod held down the grade is not affected abnormally while the sight to the rod held up the grade is usually close to the ground and must pass through the layers of lower density near the earth's surface. This sight would be less refracted than the one down the grade and may even be negatively refracted, therefore the morning running would give too small a difference between the zeroes of the rods sighted on from one station. It is the speaker's belief that, other things being equal, a line of levels run over steep grades in two directions in the afternoon, from noon to about one hour before sundown, will give results closer to the truth than levels with both runnings in the forenoon or with one leveling in the forenoon and the other in the afternoon. It is believed that this also applies to leveling over slopes of moderate grade.

The following table gives data for leveling done under different conditions of the sky. The letter C stands for cloudy and S for sunshine or clear.

RUNNINGS IN CLOUDY AND CLEAR WEATHER

	Steep Grades	Low Grades
Number of sections	56	217
$C-S$, total, positive	+ 159.2	+ 473.1
Mean discrepancy	+ 2.84	+ 2.18
Number of sections	45	228
$C-S$, total, negative	— 85.1	— 482.3
Mean discrepancy	— 1.89	— 2.12
Number of sections	101	445
Mean discrepancy	2.42	2.15
Accumulated discrepancy	+ 74.1	— 9.2
Mean accumulation per section	+ 0.73	— 0.02

The mean accumulated discrepancy here is +0.73 for the steep grades while for the low grades it is practically zero.

It is the general belief among geodesists that the leveling under a cloudy sky is practically free from systematic errors resulting from atmospheric conditions. Therefore it would appear that the leveling under a clear sky causes the observed differences in elevation on steep grades to be too small.

In the following table are given data for the steep sections which had one running in clear and the other in cloudy weather, but the data are arranged in two groups, one where the running in sunshine was made in the morning called (SA) while the other has the running in sunshine made in the afternoon (SP):

RUNNINGS WHEN CLOUDY AND ON CLEAR MORNINGS

	Steep Grades	Low Grades
Number of sections	56	240
$C-SA$, accumulation per section	+ 0.24	+ 0.11

RUNNINGS WHEN CLOUDY AND ON CLEAR AFTERNOONS

	Steep Grades	Low Grades
Number of sections	45	215
$C-SP$, accumulation per section	+ 1.34	— 0.21

The number of sections on steep grades is too small to warrant our drawing any definite conclusions from the data given. The indication from the steep section is that the afternoon running gives a value lower than the morning value.

The average accumulated values of $C-SA$ and $C-SP$ for the sections with low grade are small, +0.11 millimeter per section in the former and —0.21 millimeter per section in the latter. These sections are quite numerous as compared with the number of steep sections, and should no doubt be given some consideration before coming to a decision as to whether the morning or afternoon runnings in sunshine give the larger differences.

The data in the following table show some relations between the systematic errors of leveling and calm and windy weather. The letter C stands for calm and W for wind.

RUNNINGS IN CALM AND IN WIND

	Steep Grades	Low Grades
Number of sections	63	277
$C-W$, total, positive	+ 140.0	+ 544.3
Mean discrepancy	+ 2.22	+ 2.0
Number of sections	75	345
$C-W$, total, negative	— 199.8	— 757.4
Mean discrepancy	— 2.66	— 2.20
Number of sections	138	622
Mean discrepancy	2.46	2.11
Accumulated discrepancy	— 59.8	— 203.1
Mean accumulation per section	— 0.43	— 0.33

Both for the steep and low grades the runnings during wind give on an average greater differences in elevation between the ends of a section than the runnings during calm. The average is almost as large for the low grades as for the steep ones. This can not be considered to be a general rule for other factors may and probably do influence the results. All of the lines are in the western portion of the United States where it is usually more windy in the afternoon than in the morning. Calm is infrequent there in the afternoon. Therefore the value of $C-W$ would be somewhat confused with the value of $P-A$.

If both runnings are made in the forenoon or both in the afternoon, then the values of $C-W$ should be practically free from the effect of the time of the day. In the following table there are given the data for such sections, the amount of grade not being considered.

SECTIONS WITH BOTH RUNNINGS IN THE MORNING OR BOTH IN THE AFTERNOON

Number of sections	85
C–W, total, positive	+ 177.2
Mean discrepancy	+ 2.08
Number of sections	90
C–W, total, negative	— 222.3
Mean discrepancy	— 2.47
Number of sections	175
Accumulated discrepancy	— 45.1
Mean accumulation per section	— 0.26

The effect of morning and afternoon conditions being eliminated (but not the cloudy or clear sky) we have a result which shows a larger value on an average for the running in wind than the one in calm.

There are 495 sections, each of which had one running in the morning and one running in the afternoon with both runnings made during calm. These sections should have values for P–A which are free from the effect of calm and wind. The data for these sections are shown below. The grade is not considered.

SECTIONS RUN IN BOTH DIRECTIONS DURING CALM

Number of sections	259
P–A, total, positive	+ 603.5
Mean discrepancy	+ 2.33
Number of sections	236
P–A, total, negative	— 497.5
Mean discrepancy	— 2.11
Number of sections	495
Accumulated discrepancy	+ 106.0
Mean accumulation per section	+ 0.21

The results in the above table are free from the effects of wind and calm, but may be and probably are somewhat affected by cloudy or clear sky. But the indication is that the afternoon running is greater than the forenoon, on an average.

If it is assumed that the running in wind is free from error, then the data for the sections shown below should give an indication as to whether an afternoon or forenoon running of a section will give the greater difference in elevation. The amount of grade is not considered.

The term $(C$–$W)A$ represents calm minus wind, with the calm running in the forenoon, while $(C$–$W)P$ is the same, except that the calm running is in the afternoon.

	Mm.
Number of sections 256, total positive value	$(C$–$W)$ A + 499.2
Number of sections 330, total negative value	$(C$–$W)$ A — 759.0
Number of sections 94, total positive value	$(C$–$W)$ P + 221.7
Number of sections 87, total negative value	$(C$–$W)$ P — 182.3
Mean accumulated discrepancy per section for	$(C$–$W)$ A — 0.44
	$(C$–$W)$ P + 0.22

The indications from these data are that the difference from the calm running in the forenoon is too small and from the calm running in the afternoon too great, upon the assumption that the running in wind is without error. This bears out the conclusion stated earlier in this paper that the afternoon running gives a greater difference in elevation than the morning running.

CONCLUSIONS

While the data used in the investigation into the sources of error in precise leveling are not sufficient to warrant any definite statements, yet they seem to justify the following conclusions as probable.

1. The average size of the discrepancy between the values of the difference in elevation determined twice under different conditions does not give a clear idea of the magnitude of the accidental errors which may be produced by certain conditions, as the custom is to make the length of sight as great as the conditions will permit. Therefore, the extra length of sight may offset otherwise favorable conditions and give a large difference between two runnings of a section.

2. For sections run twice under different conditions the average accumulated value of the discrepancy is greater for the sections with steep grades than with low grades; the direction of the running being ignored and only the actual difference in elevation between the ends of a section being considered.

3. On all grades, but more especially the

steep ones, the difference in elevation determined in the afternoon is on an average greater than that determined in the forenoon.

4. On an average, a running during wind gives a greater difference in elevation than one during calm. The amount of this difference is somewhat greater for the steep than for the low grades.

5. On an average a running when the sky is cloudy gives a larger difference in elevation between two points, on a steep grade, than a running while the sun is shining. For low grades there is practically no difference, on an average, between the runnings under the two conditions.

6. For steep grades (about 10 meters per kilometer) the probability is that the afternoon running gives, on an average, a result closer to the truth than the forenoon running. The afternoon running should be ended sometime before sundown. The running in wind probably gives results on an average closer to the truth than a running in calm.

7. While the data in the tables given above make these conclusions justifiable, yet, owing to the fact that there are so many conditions to be considered, it is impracticable to obtain at present any reliable numerical values for the effect of any given atmospheric condition or set of conditions.

8. It is believed that, other things being equal, the running in the afternoon (if not within about an hour of sunset) gives, on an average, more accurate results than the forenoon running; also that, other things being equal, a running in wind is more accurate, on an average, than one in calm; and, that other things being equal, a running with a cloudy sky will be more accurate, on an average, than one in sunshine. Hence, the ideal condition would be an afternoon with a moderate wind and a cloudy sky.

9. It is believed that the mere fact of running backward or forward has no real effect on the result of a running, as the value of $B-F$ may vary in sign for different lines and even for different parts of a single line.

William Bowie

U. S. Coast and Geodetic Survey

BESSEY HALL AT THE UNIVERSITY OF NEBRASKA

Dr. Bessey is gone, but he leaves with us an imperishable memory. He was the first professor in the natural science group to remain long with the University of Nebraska and to leave an indelible mark upon it. It is fitting that the permanent home of two fundamental natural sciences in the university should be named in his honor.

The writer believes that he first suggested naming such a building after Dr. Bessey when he penned for the approval page 21 of the biennial report of 1911–12. This report contains the sentence:

> The inadequate and dangerous building known as Nebraska Hall should be removed and an adequate building called Bessey Hall in honor of Dr. Bessey erected to house the natural sciences.

Nevertheless when he wrote these words it was then as now the writer's opinion that in general no building built at public expense should be named after the living. Dr. Bessey was great enough so that this exception was planned, but his lamented death prevented the exception being made. Let us now render his memory a special honor by resolving that hereafter no building shall be named for any one until his life's work is complete. This is in harmony with the regents' act in deciding that hereafter the title of head dean shall not be awarded.

Some of the special friends of Dr. Bessey are disappointed that the building is not to be located on a more conspicuous site. To these I would say that Dr. Bessey insisted on only one thing—north light for the use of his microscopes. He was, however, pleased to have the building located away from the noise and dust of heavy traffic. The location as now determined met his critical approval. The building will have north windows along its main side and will be so located that no other university building can by any possibility obstruct the view.

The building will have three stories above ground. The basement, not to be used for class-room purposes, will be utilized for lockers, toilet rooms, store rooms, constant tem-

perature rooms and other features of a modern laboratory of natural science. The entire space of the building will be divided almost equally between the departments of botany and zoology. Commodious offices and a number of special rooms for the use and comfort of the occupants will be provided. The building will be 235 feet long and 75 feet wide in its widest part. The center of the building facing south will open upon the space reserved for greenhouses. The building itself is to be of brick, hard burnt, of a reddish brown color, selected with a certain roughness and bloom on the surface. The mortar joints will be wide and raked. The trimming will be of Bedford stone. This material will also form the facing of the building as high as the base of the windows on the first floor.

The building itself is to be of the steel wall-bearing type and will be thoroughly fireproof. In this type of structure the masonry of the walls carries part of the weight of the frame while the frame itself supports the floors, partitions and roof.

In harmony with all the new buildings of the university the building will be of classic architecture. It will depend for its beauty on graceful lines and symmetry rather than on expensive ornamentation. In harmony with Dr. Bessey's character we shall try to make the building just as permanent as the building skill of the times through the use of brick, steel and concrete will permit. It ought to stand for 500 years at least. Further, in keeping with Dr. Bessey's character it will be attractive without ostentation, built for permanence and usefulness rather than show.

Aside from the sentiment connected with its erection it will be a building much needed by the university. Botany and zoology have never had adequate quarters here. This will house them in a way worthy of a great university. While these departments will have considerably more space than they have at present, we are not building large enough to care for their growth for many years to come. When the number of students of botany becomes too large for the new quarters, we can build a separate building for zoology, leaving the entire space of the Bessey building to botany.

The building will cost approximately $200,000 when completed and finished. The university considers itself fortunate in the fact that the lowest bid was made by a firm which has not only the reputation of doing excellent work but of doing its work promptly. This firm agrees to complete the general construction in 120 working days. Assuming, then, that there is not too much cold and stormy weather during the spring and summer following, there should be no difficulty in having the building ready for use at the beginning of the next school year. The ground is now ready so that the excavation may begin at any time.

For a few hundred dollars a beautiful memorial tablet could be placed in the principal hall of the new building. Some of the former students of Dr. Bessey have attained wealth. Would not some one of them like to volunteer to place a memorial worthy of his beloved teacher where the thousands of students that will throng this building in the years to come may look upon his features cast in enduring bronze by some skilled workman after the clay model of some great artist? The regents of the university will be pleased to accept and place in a suitable place such a tribute.

S. Avery

THE COLUMBUS MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The sixty-eighth meeting of the American Association for the Advancement of Science, and the fourteenth of the "Convocation Week" meetings, will be held in Columbus, Ohio, from December 27, 1915, to January 1, 1916. Hotel Chittenden will be the headquarters.

The council will meet on Monday morning, December 27, and each following morning.

The opening general session of the association will be held at 8 o'clock P.M. on Monday, December 27, in the university chapel of university hall. The meeting will be called to order by the retiring president, Dr. Charles William Eliot, who will introduce the president of the meeting, Dr. William Wallace Campbell. Addresses of welcome will be made by President W. O. Thompson, of the Ohio

State University, and others to be announced, to which President Campbell will reply. The annual address of the retiring president, Dr. Charles W. Eliot, will then be given on "The Fruits, Prospects and Lessons of Recent Biological Science." Following the adjournment of the general session there will be a reception in the library, tendered by the Ohio State University, to members of the association and affiliated societies, with accompanying ladies.

The sections of the association and the special societies will hold their meetings through the week. Addresses of retiring vice-presidents of the association are as follows:

Vice-president H. S. White, before the Section of Mathematics and Astronomy: "Poncelet Polygons."

Vice-president Anthony Zeleny, before the Section of Physics: "The Dependence of Progress in Science on the Development of Instruments."

Vice-president F. R. Lillie, before the Section of Zoology: "The History of the Fertilization Problem."

Vice-president G. P. Clinton, before the Section of Botany: "Botany in Relation to American Agriculture."

Vice-president E. E. Rittenhouse, before the Section of Social and Economic Science: "Upbuilding American Vitality: the Need for a Scientific Investigation."

Vice-president R. M. Pearce, before the Section of Physiology and Experimental Medicine: "The Work and Opportunities of a University Department for Research in Medicine."

Vice-president P. H. Hanus, before the Section of Education: "City School Superintendents' Reports."

Vice-president L. H. Bailey, before the Section of Agriculture: "The Forthcoming Situation in Agricultural Work (Part II.)."

The following societies have indicated their intention to meet in Columbus during Convocation Week in affiliation with the American Association for the Advancement of Science:

American Society of Naturalists.—Meets on Thursday, December 30. Will hold symposium with American Society of Zoologists on Recent Advances in Fundamental Problems of Genetics. Annual dinner, same date, at 7 P.M., with presidential address by F. R. Lillie. Secretary, Dr. B. M. Davis, University of Pennsylvania, Philadelphia, Pa.

American Society of Zoologists.—Meets in joint session with Section F, A. A. A. S. Will hold symposium with American Society of Naturalists on Thursday, December 30, as above announced. President, William A. Locy. Secretary, Dr. Caswell Grave, Johns Hopkins University, Baltimore, Md.

Entomological Society of America.—Meets on Wednesday, Thursday and Friday, December 29, 30 and 31. Annual public address by Dr. C. Gordon Hewitt. Wednesday, December 29, at 8 P.M. President, V. L. Kellogg. Secretary, Professor Alex. D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

American Association of Economic Entomologists.—Meets on Monday, Tuesday and Wednesday, December 27 to 29. President, Glenn W. Herrick. Secretary, Albert F. Burgess, Melrose Highlands, Mass.

American Physical Society.—Meets on Tuesday, Wednesday and Thursday, December 28, 29 and 30, in joint session with Section B. President, Ernest Merritt. Secretary, Dr. Alfred D. Cole, Ohio State University, Columbus, Ohio.

Botanical Society of America.—Meets on Monday to Friday, December 27 to 31. Will hold joint meeting with Section G, A. A. A. S., on Tuesday afternoon, December 28, and with American Phytopathological Society on Thursday afternoon, December 30. Annual dinner for all botanists will be held Wednesday evening, December 29, at Hotel Hartman. President, John M. Coulter. Secretary, Harley H. Bartlett, Botanical Laboratory, University of Michigan, Ann Arbor, Mich.

American Phytopathological Society.—Meets on Tuesday to Friday, December 28 to 31. Will hold joint meeting with Section G, A. A. A. S., on Tuesday, December 28, and with Botanical Society of America on Thursday, December 30. President, H. H. Whetzel. Secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

Botanists of the Central States—Will hold no separate meeting, but will present its papers in connection with Section G, A. A. A. S. Secretary, Dr. Edward A. Burt, Missouri Botanical Garden, St. Louis, Mo.

Society for Horticultural Science.—Meets on Tuesday to Thursday, December 28 to 30. President, W. L. Howard. Secretary, Professor C. P. Close, College Park, Maryland.

Association of Official Seed Analysts of North America.—Meets on Tuesday and Wednesday, December 28 and 29. President, W. L. Oswald. Secretary, John P. Heylar, Agricultural Experiment Station, New Brunswick, N. J.

American Microscopical Society.—Will hold executive committee luncheon on Tuesday, December 28, at 12:30 P.M., followed by business meeting, same date, at 5 P.M. President, C. A. Kofoid. Secretary, Professor T. W. Galloway, James Millikin University, Decatur, Ill.

American Mathematical Society (Chicago Section).—Meets on Thursday, Friday and Saturday, December 30 to January 1. Will hold joint meeting with Section A, A. A. A. S., on Thursday, December 30, at 2 P.M. Secretary, Chicago Section, Professor H. E. Slaught, 5548 Kenwood Avenue, Chicago, Ill.

American Federation of Teachers of the Mathematical and the Natural Sciences.—Will meet on dates to be announced. Secretary, Professor William A. Hedrick, McKinley Manual Training School, Washington, D. C.

American Nature-Study Society.—Meets on Thursday and Friday, December 30 and 31. Will hold joint session with School Garden Association of America on Thursday, December 30, at 2:30 P.M. President, L. H. Bailey. Secretary, Professor E. R. Downing, University of Chicago, Chicago, Ill.

School Garden Association of America.—Meets in joint session with American Nature-Study Society on Thursday, December 30, at 2:30 P.M. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

Society of the Sigma Xi.—Will meet on dates to be announced. President, Dr. Charles S. Howe, Case School of Applied Science, Cleveland, Ohio.

Wilson Ornithological Club.—Will meet on dates to be announced. President, T. C. Stephens, Morningside College, Sioux City, Iowa.

Gamma Alpha Graduate Scientific Fraternity.—Will meet on dates to be announced. Recorder, L. C. Johnson, 613 West Michigan Avenue, Urbana, Ill.

SCIENTIFIC NOTES AND NEWS

THE Nobel prize for physics for 1914, according to a Reuter dispatch from Stockholm, has been awarded to Professor Max von Laue, of Frankfort-on-Main, for his discovery of the diffraction of rays in crystals. The prize for chemistry for the same year has been awarded to Professor Theodore William Richards, of Harvard University, for fixing the atomic weights of chemical elements.

DR. WALLACE BUTTRICK, director of the China Medical Board, of the Rockefeller Foundation, Dr. Simon Flexner, of the Rockefeller Institute for Medical Research, and Dr. William H. Welch, professor of pathology at Johns Hopkins University, were the guests of honor at the recent dedication of the new Sleeper-Davis Memorial Hospital, Peking, China. The new building is a five-story structure erected by the Methodist-Episcopal Church at a cost of $180,000.

THE Romanes lecture before the University of Oxford will be delivered this year by Professor E. B. Poulton, Hope professor of zoology in the university, on December 7. The subject will be "Science and the Great War."

THE honorary degree of D.Sc. was conferred on October 26 on Mr. Guy A. K. Marshall, director of the recently established Imperial Bureau of Entomology.

DR. J. HORNE has been elected president of the Royal Society of Edinburgh. The vice-presidents of the Royal Society are: Professor F. O. Bower, Sir T. R. Fraser, Dr. B. N. Peach, Sir E. A. Schäfer, the Right Hon. Sir J. H. A. Macdonald and Professor R. A. Sampson.

THE Berlin Geographical Society has elected General von Beseler as its president.

DR. SVEN VON HEDIN has been elected a corresponding member of the Vienna Academy of Sciences.

WE learn from *Nature* that Mr. W. Marriott has retired from the post of assistant secretary of the Royal Meteorological Society held by him for the last forty years, and has been succeeded by Mr. A. H. Brown, the chief clerk of the society.

DR. HERMAN FISCHER, formerly professor of surgery in Breslau, has celebrated his eighty-fifth birthday.

DR. ALFRED WERNER has been made a member of the *Reichsanstalt*, Berlin.

DR. KARL H. VAN NORMAN, first assistant superintendent of Johns Hopkins Hospital, has resigned to accept a captaincy in a Canadian regiment.

PROFESSOR F. J. ALWAY, of the department of chemistry of soils of the University of Minnesota, has been elected president of the Min-

nesota section of the American Chemical Society.

Dr. Clark Wissler and Dr. Robert H. Lowie, of the American Museum of Natural History, have been appointed delegates from the New York Academy of Sciences to the Nineteenth International Congress of Americanists which meets in Washington at the end of December.

It is stated in *Nature* that in addition to the awards announced in April for papers read at the meetings, the council of the Institution of Civil Engineers has made the following awards for papers published in the *Proceedings* during the session 1914–15: A Telford gold medal to Mr. James Forgie (New York); Telford premiums to Messrs. J. R. Mason (Dunedin, N. Z.), Harold Berridge (Aden), C. R. White (London), C. S. Churchill (Roanoke, Va.), and the Trevithick premium to Mr. A. Poulson (Lemvig, Denmark). The Indian premium for 1915 has been awarded to Mr. C. W. Anderson (Midnapore, India). The ninety-seventh session of the Institution was opened on November 2, when Mr. Alexander Ross, president, delivered an address and presented the awards.

Mr. Frank C. Baker, until recently acting director of the Chicago Academy of Sciences, now zoological investigator for the New York State College of Forestry at Syracuse University, gave a popular illustrated lecture in the lecture course of the Syracuse Chapter of Sigma Xi on November 8 on "Hunting Birds with a Camera."

Robert Allyn Budington, professor of zoology in Oberlin College, lectured recently on "Some of the Results of Biological Study," at Goucher College, where the department of biology has recently moved into new and enlarged laboratories.

The general meeting of the Röntgen Society, London, was held on October 4, at the Institution of Electrical Engineers, when the president, Mr. J. H. Gardiner, delivered an address and new apparatus was exhibited.

Dr. Charles F. Chandler, professor emeritus of Columbia University, has given for the department of arts and sciences of the University three lectures on "The Art of Photography."

The twenty-third summer meeting of the American Mathematical Society will be held at Harvard University early in September, 1916. At the eighth colloquium of the society, held in connection with this meeting, courses of lectures will be delivered as follows: By Professor G. C. Evans: "Topics from the Theory and Applications of Functionals, including Integral Equations." By Professor Oswald Veblen: "Analysis Situs."

Edward Lee Greene, associate in botany at the Smithsonian Institution since 1904, recently elected head of the botanical department of Notre Dame University at South Bend, Ind., died in Washington on November 10, aged seventy-two years. From 1885 to 1895 Dr. Greene was professor of botany in the University of California, and from 1895 to 1904 in the Catholic University of America.

Sir Andrew Noble, F.R.S., distinguished for his scientific work on artillery and explosives, died on October 22, at eighty-four years of age.

Professor Vivian B. Lewis, until last year professor of chemistry in the Royal Naval College, died on October 23, aged sixty-three years.

Dr. R. Assheton, F.R.S., university lecturer in animal embryology at the University of Cambridge, died on October 23, aged fifty-one years.

Dr. Ernst Werner Maria von Olfers, known for his work in sanitation, has died at Königsberg in his seventy-fifth year.

The sequence of events so often observed in the history of gold-mining camps has been repeated in the Willow Creek district, Alaska. The earliest prospectors, in 1897, were primarily interested in the search for placer gold and having found it were too busily engaged in mining to trace the stream gold to the veins from which it originally came. It was nearly ten years later that the first of the valuable quartz veins that now yield most of the gold mined in the district was discovered. Since,

1906, however, quartz mining has progressed steadily and has rested upon a substantial basis. In 1913 the production of the district for the first time exceeded \$100,000, but in 1914 it was almost treble that amount. Three mills are in operation, and more will soon be installed. With the increase in the depth of mining the veins show no diminution in the amount or tenor of the gold. A study of the geologic conditions in this general area leads to the conclusion that veins similar to those now worked may be found beyond the borders of the present mining district, and prospects already being developed confirm this conclusion. The district lies near the route of the government railroad from Seward to Fairbanks, and the cheaper transportation should greatly stimulate its development. There is thus every indication that the Willow Creek district will steadily increase in importance as a gold-mining camp and that it will have a long period of productiveness. Since the district's establishment as a gold quartz mining camp the gold placers which originally were regarded as the only valuable gold deposits, have decreased in importance until their annual output is now small, yet under the more favorable conditions of transportation soon to be realized it is possible that placer mining may again be profitably carried on. A report on the Willow Creek district by S. R. Capps, published as Bulletin 607 of the United States Geological Survey, includes in addition to a description of the mines and prospects, a discussion of the history, geography and geology of the district. The report is illustrated by a topographic and a geologic map on a scale of about 1 inch to the mile, and by numerous photographs and text-figures.

A PHASE of the study of the underground waters of southern Louisiana is their utilization in the cultivation of rice by irrigation. In 1888 lowlands near the bayous suitable for growing sugar cane, corn and cotton could be purchased for \$3.50 an acre, and the prairie lands back from the bayous could be bought for \$1 an acre. With almost the first crop under irrigation, however, the values showed a marked rise and have continued to increase. In the first five years the value of the best rice lands rose to \$10 an acre, and soon after that it rose to \$30 and even \$50 an acre. The first people to plant rice in southern Louisiana, according to the United States Geological Survey, were the Acadians, who, after their expulsion from Nova Scotia by the English in 1755, settled in considerable numbers in Louisiana. Their cultivation of rice, almost absolutely primitive in its methods, was confined to the lowlands along the bayous, the prairies affording pasturage for the Acadians' herds of cattle. Few of the lowland areas admitted of satisfactory drainage, and they were too small for profitable cultivation. The crops frequently failed in years of deficient rainfall. Attempts were made to create additional water supplies by building levees across low sags or coulees at points higher than the cultivated areas, but generally either the rainfall proved deficient or the reservoirs were too small. Little advance was made over the Acadian methods until very recently. Experiments in unusually wet years had shown that the soils of the prairies were adapted to the growth of rice if sufficient water was at hand. This led to the trial of pumps as a means of raising water from the bayous to the rice fields. So successful was the test that pumps were at once installed at many points, and in a few years tens of thousands of acres of previously almost useless land, lying 10 to 70 feet above the bayous, were put under cultivation. The first large pump was installed in 1894 on the Bayou Plaquemine, in Acadia Parish, near Crowley. Although its failure at a critical time involved the partial loss of the crop, it showed that rice could be cultivated by pumping, which has been gradually adopted on larger and larger scales until now in the larger plants batteries of pumps operated by compound Corliss engines are in common use.

THE archeological work carried on in Manitoba for the Geological Survey, Canada, by Mr. W. B. Nickerson, has been completed for the season. An artificial mound was found on the most conspicuous headland overlooking the Assiniboine River about six miles north of Alexander. This Mr. Nickerson explored and found to be a burial mound. Among the finds were one hundred and sixty-two marine shells

and six cylindrical objects—beads or pendants—made of the columella of the conch. They indicate trade or expedition as far as the sea. Two groups, each of more than one hundred gravel mounds, on terraces in the Assiniboine Valley, were found to be of natural origin, although resembling artificial burial mounds in appearance. No mounds were found in the valley of the Little Saskatchewan, and slight evidence of habitation. Near Arden, Mr. Nickerson explored a long mound, consisting of two dome-shaped ends with a connecting grade, and a broad, dome-shaped mound, in which were found parts of three human skeletons, a perforated disc made of shell, and two objects made of bone, probably used as bracelets. A third mound, within the village of Arden, had been previously disturbed. Several camp sites were found at the foot of the Assiniboine Hills at springs forming small streams, also in the vicinity of Arden, along the White Mud River. Mr. Nickerson took seventy-five photographic films in connection with this work and secured a number of gifts for the Dominion collections.

UNIVERSITY AND EDUCATIONAL NEWS

As was noted in SCIENCE last week, Columbia University received by the will of Amos F. Eno the residuary estate. It also receives a revisionary interest in certain bequests. In addition, the General Society of Mechanics and Tradesmen receives $1,800,000, and bequests of $250,000 each are made to New York University, The American Museum of Natural History, the Metropolitan Museum of Art and the New York Association for Improving the Condition of the Poor.

MR. AND MRS. NORMAN W. HARRIS, of Chicago, have increased their gift of $25,000 to Mount Holyoke College made at the time of the seventy-fifth anniversary, to $50,000, for the endowment of the chair of zoology. Mrs. Harris is a graduate of the college of the class of 1870.

THE date for the dedication of the new buildings of the Massachusetts Institute of Technology has been fixed by the executive committee of the corporation for June 14, 1916. Practically all the stonework of the buildings has been completed and nearly all the carving, which in addition to the decorative features of capital, cornice and portico, will include the names of the founders of science incised about the towers. In the interior the floors are in process of finishing, this being done by means of electric polishers, which are carrying on the work at the rate of 2,500 square feet a day. The rough plumbing is practically all in place and the installation of fixtures is under way. In ten of the buildings the steam heating system is ready and later this month, when the boiler house is completed, the buildings will be dried out by steam heat.

AT the University of Minnesota efforts are being made to bring faculty and regents into closer personal relations. At a general assembly of the whole teaching staff held September 27 ten of the twelve regents of the university were present and made brief addresses. The president of the board, Mr. Fred B. Snyder, emphasized the fact that the regents regarded the faculty members not as employees but as colleagues responsible for the really important work of the university. He made an appeal for the hearty cooperation of all concerned for the welfare of the institution. On the evening of November 3 the new members of the faculty were invited to meet the regents at the house of the president of the university. For December 14 a dinner is being arranged by a faculty committee. On this occasion there will be an informal discussion in which it is expected that both faculty and regents will express their views about university ideals and policies.

PROFESSOR T. W. GALLOWAY, Ph.D., who has occupied the chair of biology at James Millikin University at Decatur, Ill., since the establishment of that institution in 1903, has been appointed professor of zoology at Beloit College, Beloit, Wisconsin. A. A. Tyler, Ph.D. (Columbia, '97), for some years professor of biology in Bellevue College, Omaha, Nebraska, has been appointed to the chair of biology at

James Millikin University, to succeed Dr. Galloway.

J. A. Moyer, professor of mechanical engineering in the Pennsylvania State College and director of the college extension work, has been appointed by Governor Walsh to the directorship of the extension service which is to be organized in Massachusetts.

James Kendall, D.S., has been promoted to be assistant professor of chemistry in Columbia University.

Dr. L. G. Rowntree, of the department of medicine of Johns Hopkins University, has been elected professor of medicine and chief of the department of medicine in the University of Minnesota Medical School. Dr. Rowntree will devote practically his entire time to the service of the medical school, although he will have the privilege of seeing a limited number of patients who may be referred to him by physicians.

At the University of Michigan, Junior Professors Peter Field, L. C. Karpinski and T. R. Running have been promoted to associate professorships of mathematics. Drs. Tomlinson Fort and T. H. Hilderbrandt have been promoted from instructorships to assistant professorships of mathematics. Dr. A. L. Nelson has been appointed instructor in mathematics.

DISCUSSION AND CORRESPONDENCE

THE PUBLICATION OF NEW SPECIES

In these days when taxonomic literature has reached such enormous proportions and is growing so rapidly that even the specialist has difficulty in keeping up with the literature of his own particular group, it seems to me that the interests of science would be better subserved by the use of greater care in selecting the medium of publication of new species. The pages of such general magazines as Science should be devoted to papers of general interest to the scientific, and to scientific papers of a nature unsuited to the special periodicals. For example, with a magazine in America devoted exclusively to Mollusca, why should an occasional new species of mollusk be published in Science, thus compelling the student of mollusks to search the files of that bulky magazine in order to be sure of missing nothing in his systematic work? Why not send it to a magazine especially devoted to the subject? With several excellent bird magazines in the United States, why should a technical discussion of the taxonomic status of a bird species appear in Science? With magazines exclusively devoted to botany, why should a new species of plant found in Colorado be published in an annual report of an experiment station in a far distant state, a volume in which surely no botanist could be expected to look for such a description if he were working upon the plants of that particular group or that particular region? Are not the difficulties of systematic botanical and zoological work great enough without vastly enhancing them by scattering the descriptions of new species? The examples above given are mere samples of scores of similar instances which come to our attention every year, to the discouragement of hard-worked students, and especially those remote from very large libraries. Furthermore, there are altogether too many ephemeral publications of small educational institutions and local scientific societies, having very limited circulation, but publishing strictly taxonomic papers which often fail to reach the attention of specialists for years, and then suddenly bob up to cause confusion in nomenclature. To make matters worse, descriptions of new species sometimes appear in leaflets or small pamphlets, published privately or by some small institution or society and not forming part of any series into which they would be finally bound and thus preserved. What happens to such a leaflet when it reaches a library? Is it not usually lost? Is it likely to be easily available to the student of ten or twenty years hence, as it would be if published in *The Nautilus*, or *The Auk*, or *The Botanical Gazette*, or even in *Nature* or Science? In how many libraries may a student be able to find it in fifteen years? Although many new species are described at the University of Colorado, that institution has wisely excluded all such descriptions from its *Studies* and *Bulletin*, taking the position that they should appear in

periodicals especially devoted to the particular subjects, or in publications which have wide circulation and are well known to habitually publish such papers. If all publishers and naturalists would take the same position it would surely greatly simplify the work of the future systematist. JUNIUS HENDERSON

THE EFFECT OF CYANIDE ON THE LOCUST-BORER AND THE LOCUST-TREE

DURING the past five years a number of experiments have been made from the office of the Illinois state entomologist with methods for destroying the black locust-borer (*Cyllene robinæ*). From articles appearing in SCIENCE during the last few months, especially those by Professor Fernando Sanford in the issue of October 9, 1914, and by Professor C. H. Shattuck in the issue of February 26, 1915, it seemed probable that at least a part of the borers in infested locust-trees might be killed by introducing small amounts of potassium cyanide into the trunk and bark.

Early in the spring of 1915, fifty black locust-trees, fourteen in a small grove at Athens, in central Illinois, and thirty-six in a large plantation at Union Grove, in northwestern Illinois, were treated with potassium cyanide and sodium cyanide in the following manner:

The trees selected were from one to seven inches in diameter and were nearly all badly infested with the larvæ of the locust-borer. The borers were still in their overwintering cells in the bark, but were just becoming active at the time. The cyanide was placed in the trees in auger-holes of one fourth, one half, three fourths, and one inch diameter, bored at different heights from the ground and different depths into the trunk. The amounts of cyanide used in single trees varied from one twentieth to one half an ounce. The chemicals used were potassium cyanide, 98 per cent. pure, in small lumps, and cyanide-chloride carbonate mixture in granular form, guaranteed to contain 35–38 per cent. sodium cyanide. After the cyanide had been placed in the trees, the auger-holes were tightly plugged with corks driven in with a hammer.

The fourteen trees at Athens were treated March 12, and the thirty-six trees at Union Grove, April 1, 1915. The results of the treatments were taken at Union Grove July 13 and at Athens July 15, 1915.

The results of this experiment showed no benefit by the treatment. Of the fifty trees treated, eight could not be located in the summer, owing to the dense growth of weeds and sprouts. The treatment of these eight trees did not differ materially from that given the forty-two examined, and could not have made any marked difference in the results. Of the forty-two trees examined in July, twenty-three were dead and nineteen alive. Of the nineteen living trees, all but three contained living larvæ of *Cyllene robinæ*. In several cases living borers were found directly above and within six inches of the auger-holes, and in three cases the borers were within one inch of the auger-holes. Not only were the borers alive in the living trees, but in all cases where the trees had put forth leaves in the spring of 1915, living borers were present in numbers in the trunks, and could be found around the bases of the trunks of many of the trees that had not shown foliage the past spring. Not a single dead borer was found near the points where the cyanide had been placed.

While over half of the trees treated were dead, this was not entirely due to the effects of the cyanide, as at least twenty-five per cent. of the untreated trees in both groves had died from the effects of borer injuries. There can be no doubt, however, that the cyanide had a very injurious effect on the trees, as in all the living trees the bark was dead and the wood discolored for a greater or less distance around the holes where the cyanide had been placed.

It was an interesting fact, which has, however, no bearing on the effect of the cyanide on the trees, that some rodents, probably rabbits, had gnawed many of the trees around the auger-holes, deeply scoring the wood. There was no residue from the cyanide in any of the auger-holes when examined in July, whether the corks had been removed or not, and no odor of the cyanide could be detected in the wood.

No chemical tests were made for the presence of cyanide.

WESLEY P. FLINT
STATE ENTOMOLOGIST'S OFFICE,
URBANA, ILL.,
August 6, 1915

A NEW MITOTIC STRUCTURE

IN the *Journal of the Royal Microscopical Society,* April, 1915, Mr. E. Sheppard, F.R.M.S., published a paper entitled "A New Mitotic Structure Disclosed as the Result of New Technique." He describes at the ends of the dividing chromosomes "bead-like chromatin extensions" where the spindle fibers are attached. I want to draw his attention to the fact that these structures are well known to cytologists and that there is no special technique needed for their disclosure. My own experience is that they are most extremely developed in the maturation divisions of Trematodes. I have figured them in my paper "Die Chromatinreifung der Geschlechtszellen des Zoogonus mirus, etc.," *Arch. Zellforschg.,* Vol. 2, 1908. Better figures are found in Grégoire's publication, based on the same slides "La réduction dans le Zoogonus mirus, etc.," *La Cellule,* 25, 1909. He calls these structures "renflement d'insertion." For *Fasciola hepatica* they are described by A. Schellenberg, "Ovogenese, Eireifung und Befruchtung von *Fasciola hepatica* Arch. Zellforschg.," Vol. 6, 1910, and I know their presence in some other trematodes.

R. GOLDSCHMIDT

A METHOD OF MAINTAINING A SUPPLY OF PROTOZOA FOR LABORATORY USE

ONE of the difficulties that confront the teacher of elementary biology, especially in those institutions where a large number of students must be provided for, is that of obtaining a satisfactory supply of protozoa, especially of such forms as *Ameba, Euglena* and *Paramecium.* I have overcome this difficulty in such a simple manner that it may be worth while to state briefly how I keep a supply of these forms on hand. Four years ago I obtained from a pond some water and rubbish in which were present a few individuals of *Ameba, Euglena* and *Paramecium.* I prepared a culture made by boiling a handful of hay in about a half-gallon of water until the liquid assumed a dark brown color. This with a part of the hay was placed in a two-quart, cylindrical battery jar and permitted to stand open in the laboratory for twenty-four hours. The jar was then covered loosely with a pane of glass and set aside till bacteria had formed a scum over the surface of the liquid. The pond water and rubbish were then added and the jar still covered was set in a north window of the laboratory.

In a short time an abundance of *Paramecia* was present in the culture. The *Euglenæ* and *Amebæ* multiplied more slowly, but at the end of six months the jar was swarming with these two forms, while the *Paramecia* had decreased in number and were to be found chiefly at the bottom of the jar. Such a culture will usually afford a good supply for a year but I prepare a new culture every six months and stock it from the old one. By this method I have for the past four years kept on hand an abundant supply of these protozoa without going outside of my laboratory. At the opening of college I have on hand a culture newly prepared, in order to have an abundance of *Paramecia,* a second culture six months old and a third one year old. The hay infusion and the decomposing vegetable matter in the jar seem to furnish suitable food for the bacteria and *Euglena; Paramecium* feeds on the bacteria and *Ameba* on the encysted *Euglena.* Rotifers and a host of other protozoan forms abound in the cultures but the three forms most used in laboratory exercises are always present in abundance. In my laboratory I find it necessary to keep the culture in a north window; direct sunlight is not only not necessary but decidedly harmful, due probably to the heat rather than the light.

J. B. PARKER
BIOLOGICAL LABORATORY,
CATHOLIC UNIVERSITY OF AMERICA

QUOTATIONS

SCIENCE IN NATIONAL AFFAIRS

WE printed last week a valuable address by Professor J. A. Fleming on "Science in the

War and after the War." Though the address was an introductory lecture at University College, London, and was open to the public without fee or ticket, only the briefest mention of it appeared in the periodical press, and the points of national importance dealt with in it were unrecorded, except in our columns, in which it was our privilege to publish the address almost in full. We understand, of course, that the demands made upon the space available in the daily papers are many and insistent, yet we should have supposed that during the progress of a war in which victory will depend as much upon science and machinery as upon men, a summary of some of the points made by a leading authority upon applied science would be of greater public interest and importance than much of the unsubstantial chatter with which we are supplied daily.

In the course of his address, Professor Fleming himself supplied a reason for the neglect of scientific aspects of national affairs, in comparison with the attention given to the superficial views of politicians and other publicists. While success in science is measured solely by discovery of facts or relationships, in politics and public life generally it is secured by fluent speech and facile pen. In scientific work attention must be concentrated upon material fact, but the politician and the writer attach greater importance to persuasive words and phrases, and by their oratory or literary style are able to exert an influence upon public affairs altogether out of proportion to their position as determined by true standards of national value. Power, as regards government of the affairs of the nation, does not come from knowledge, but from dialectics: it is the lawyer who rules, with mind obsessed by the virtues of precedent and expediency, and to him men of science and inventors are but hewers of wood and drawers of water.

Under a democratic constitution it is perhaps too much to expect that Parliament will pay much attention to scientific men or methods; yet, as was shown in the debate upon the scheme for the institution of an advisory council of scientific and industrial research last May, the members of the House of Commons are ready to support plans for bringing science in closer connection with industry. The monies provided by Parliament for this purpose are to be under the control of a committee of the Privy Council, which will be advised by a council constituted of scientific and industrial experts. The scheme was conceived rightly enough, but when it passed into the hands of officials of the Board of Education much of its early promise was lost. Most people would regard it as essential that the executive officers of a council concerned with the promotion of industrial research should know what is done in this direction in other countries, and have sufficient knowledge of science and industry to formulate profitable schemes of work. The success of such a body depends largely upon the initiative of the secretary; and in an active and effective council we should expect him to be selected because of close acquaintance with problems of industrial development along scientific lines. But what is the position in this case? The scheme is issued by the president of the Board of Education, Mr. Arthur Henderson, a labor member, who owes his post entirely to political exigencies, the secretary of the committee of the privy council is the secretary of the board, Sir Amherst Selby-Bigge, whose amiability is above reproach, but who knows no more of practical science and technology than a schoolboy, and the secretary of the advisory council is Dr. H. F. Heath, whose interests are similarly in other fields than those of science.

The belief that the expert—whether scientific or industrial—has to be controlled or guided by permanent officials having no special knowledge of the particular subject in hand is typical of our executive system. While such a state of things exists, most of the advantages of enlisting men of science for national services must remain unfulfilled. The various scientific committees which have been appointed recently have, we believe, been able to give valuable aid in connection with problems submitted to them, but they would be far more effective if the chiefs of the departments

with which they are associated possessed a practical knowledge of scientific work and methods. Without such experience the executive is at the mercy of every assertive paradoxer and can not discriminate between impracticable devices and the judgment of science upon them. While, therefore, the country has at its disposal the work—either voluntary or nearly so—of experts in all branches of applied science, it can not use these services to the best advantage unless the departments concerned with them have scientific men among the permanent officials; and that is not the case at present.

The unbusinesslike methods of government departments have received severe criticism lately, but nothing has been said about the unscientific method of appointing committees of experts without well-qualified officers to direct or coordinate their work. The reason is that, with scarcely an exception, no daily paper has any one on its staff possessing the most elementary knowledge of the meaning of scientific research. Our guides and counsellors, both on the political platform and in the periodical press, can scarcely be expected to interest themselves greatly in subjects beyond their mental horizon, so when scientific matters are involved they confine themselves to a few platitudes, or say nothing at all. They are unable to distinguish a quack from a leading authority in science, and prefer to exercise their imaginations upon sensational announcements, rather than discuss the possibilities of sober scientific discovery. In all that relates to the interests of science—and that means in the end the interests of the nation—the men who influence public opinion and control the public services are mostly unenlightened and therefore unsympathetic.

The tacit assumption that public committees or departments concerned with scientific problems must have at their head officers of the army, navy, or civil service is responsible for delay in taking advantage of available expert knowledge and for the neglect to make effective use of science in national affairs, whether in times of war or peace. Just as a member of the government may serve in turn as president of the Board of Education, Board of Agriculture, Board of Trade, or any other department, without possessing any special qualifications to comprehend the work of either, so a public official may be placed in a position to dominate activities of which he can not understand the significance. Some day we hope that this mad system will be swept away, and that the men who exert control in all government offices will be those whose training or experience make them most capable of doing so effectively.—*Nature.*

SCIENTIFIC BOOKS

A Budget of Paradoxes. By AUGUSTUS DE MORGAN. Reprinted, with the author's additions, from the *Athenæum.* Second edition edited by DAVID EUGENE SMITH. Two volumes, I., viii + 402 pp.; II., 387 pp. The Open Court Publishing Co., 1915. Price $3.50 per volume.

The similarity between the work of David Eugene Smith and Augustus De Morgan in the field of popularizing mathematics has long been familiar to students of the history of science. This similarity has extended to many details; both men have participated in the publication of elementary text-books of excellence, both are known as editors of the mathematical department of encyclopedias and dictionaries, both have been energetic collectors of mathematical books and other mathematical material, and both have been distinguished by a wide and human interest in all phases of mathematical development. Hence it is eminently fitting that as editor of this new edition of "A Budget of Paradoxes" we should have Professor Smith, who not long ago continued so ably in the "Rara Arithmetica," De Morgan's bibliographical work, represented by "Arithmetical Books from the Invention of Printing to the Present Time" (London, 1847).

The first question which occurs to the casual reader whose eye catches the title is regarding the significance of the word "paradox." De Morgan answers this [I., 2] in a manner that even to-day has meaning for many who publish books. "A great many individuals, ever since

the rise of the mathematical method, have, each for himself, attacked its direct and indirect consequences. I shall not here stop to point out how the very accuracy of exact science gives better aim than the preceding state of things could give. I shall call each of these persons a *paradoxer,* and his system a *paradox.* I use the word in the old sense: a paradox is something which is apart from general opinion, either in subject-matter, method or conclusion." Further on in his introductory remarks De Morgan adds: "After looking into books of paradoxes for more than thirty years, and holding conversation with many persons who have written them, and many who might have done so, there is one point on which my mind is fully made up. The manner in which a paradoxer will show himself, as to sense or nonsense, will not depend upon what he maintains, but upon whether he has or has not made a sufficient knowledge of what has been done by others, *especially as to the mode of doing it,* a preliminary to inventing knowledge for himself. That a little knowledge is a dangerous thing is one of the most fallacious of proverbs. A person of small knowledge is in danger of trying to make his *little* do the work of *more;* but a person without any is in more danger of making his *no* knowledge do the work of *some.*"

How De Morgan would have enjoyed for his collection the solution (?) of Fermat's problem by Miss ———, of the New York schools, whose name will not go down in history, published by the staidest of New York evening papers; this problem to solve, or prove not solvable, $x^n + y^n = z^n$ in integers for n greater than 2 has been the subject of many similar solutions and the Wolfskehl prize of $25,000 has often been claimed and as often denied. Without fear of contradiction we may say that the final solution will be given by some able student of number theory who is not ignorant of "what has been done by others." Equally would De Morgan have welcomed the high-school boy's solution (?) of the trisection of an angle, with ruler and compass, published only three or four years ago in a journal devoted to elementary science. Particularly, too, De Morgan would have desired for his "Budget" something typical concerning our American prodigies, whose names, we note, are found more often in paragraphs than in monographs, more often in headlines than in footnotes.

How many works of to-day come within the classification of paradoxical nonsense, foisted upon the press by authors ignorant of "what has been done by others" in the fields in which these authors would instruct the public. Among these "paradoxers" are scientists of real fame in science, but without philosophy, who wish to instruct philosophers in philosophy, philosophers ignorant of the work of Georg Cantor and Dedekind who wish to instruct mathematicians about the nature of the number idea and the psychology of number, school superintendents who are profoundly ignorant of the fundamental ideas of arithmetic who wish to write text-books on arithmetic, old maids living in a two-room flat on the fifteenth floor of a New York apartment who wish to instruct the parents of the United States on the art of bringing up a large family of children, manufacturers successful in business who yearn to instruct the world in philosophy and science. These are modern *paradoxers* of the nonsense type who need another De Morgan to call attention to their folly.

"All the men who are now called discoverers, in every matter ruled by thought, have been men versed in the minds of their predecessors, and learned in what had been before them. There is not one exception. I do not say that every man has made direct acquaintance with the whole of his mental ancestry; many have, as I say, only known their grandfathers by the report of their fathers. But even on this point it is remarkable how many of the greatest names in all departments of knowledge have been real antiquaries in their several subjects.

". . . if any one will undertake to show a person of little or no knowledge who has established himself in a great matter of pure thought, let him bring forward his man and we shall see."

Let every editor have a copy of these words to enclose with rejected manuscripts which violate the principles so sanely laid down by De Morgan.

Mathematical paradoxes are largely connected with the squaring of the circle, the ratio π, the duplication of the cube, the trisection of the angle, and the number of the beast; astronomical paradoxes are quite as frequent, here, as the mathematical; religion, philosophy and medicine, too, enter in for a goodly share of attention. De Morgan had a very live interest in the history of science, and this interest finds frequent expression in the "Budget."

Not all the material, by any means, of these interesting volumes is concerned with paradoxes of the *nonsense* type. Le Verrier's planet Neptune is presented with certain original documents connected with the discovery; the names of Herschel, royal astronomer, and Brünnow, who was later director of the observatory at the University of Michigan, and Challis of the Cambridge Observatory are indications of a paradox, "something contrary to the current opinion" which was really revolutionary. Historical material appears with relative frequency, giving pleasant intervals of relief from regarding the errors of mankind.

Of particular interest are those notes which De Morgan inserts about men and affairs of his own time. The liberal footnotes added largely by Professor Smith, and occasionally by De Morgan's wife or from De Morgan's notes, contribute much to the modern reader's pleasure in perusing the volumes.

The "Budget," it need hardly be stated, was not intended to be read as a romance, although much of the material suggests that artistic rambling which is so delightfully characteristic of William De Morgan, the son of our mathematician Augustus De Morgan. Rather these are volumes to be read at odd moments, and always one will find profitable enjoyment. In spite of the interest and amusement with which we thumb the pages a feeling of sadness for the human frailty comes over the reader. De Morgan expresses this sentiment, too, in the brief but pointed comment on the work of an angle-trisector. After giving the title of the work De Morgan continues with a quotation of words from the author of the trisection, followed by five words of comment: "'The consequence of years of intense thought': very likely, and very sad."

The physical make-up of this edition is up to the high standard which has been set by other publications of the Open Court Company. In every way the reader who takes these volumes in hand has pleasure in store; we commend the works to all who take a kindly interest not only in the greatness but equally in the frailty of their fellows.

LOUIS C. KARPINSKI
UNIVERSITY OF MICHIGAN

Scottish National Antarctic Expedition. Report on the Scientific Results of the Voyage of the Scotia, during the Years 1902–4. Vol. IV., Zoology. Parts II.–XX., Vertebrates. Edinburgh, 1915. Pp. 505. 4to. 62 pl. 31 text-figures and 2 maps.

Before the voyage of the *Scotia* under the leadership of Dr. Wm. S. Bruce there had not been a deep-sea sounding taken south of S. Latitude 40° in the Atlantic Ocean. The uninviting lands of the South Orkneys, the South Shetlands and South Georgia, were rarely visited and relatively little known. As a direct result of the Swedish and Scottish expeditions in the Weddell Sea an extensive whale fishery has been developed having its headquarters at Leith. Now according to Dr. Bruce over a thousand people live in South Georgia, and during the summer months the South Orkneys and South Shetlands are a hive of industry, and altogether over five million dollars gross annual revenue is now taken in those regions previously regarded as worthless by business men.

Owing to the struggle in which the country is engaged, money for the publication of the scientific results could no longer be supplied by the treasury; and several of the reports were consequently issued in scientific periodicals, such as the *Ibis* and the *Proceedings of the Royal Physical Society;* but by the generosity of Sir Thomas Coats, the collaboration of the Scottish Oceanographical Society, the Carnegie Trust, the Royal Societies of Edinburgh and London and other friends and organizations, these and other papers are brought together in

this volume and illustrated in satisfactory form. Fifteen British naturalists have contributed papers, and the book is perhaps the most complete treatise on the Antarctic vertebrate fauna yet published.

The birds, seals, whales and fishes, are fully illustrated with excellent plates, and much space is given to anatomy, osteology and embryology; while the economic aspects of the fauna are not neglected. Papers on the tunicates and *Cephalodiscus* are included. A few forms obtained on the voyage but which are not strictly Antarctic are incidentally noticed. Altogether the members of the staff and the contributors to the explorations and publication of the results may justly congratulate themselves on the appearance of this handsome volume at a time when general attention is unfortunately diverted from matters of science and focused on the preservation of the empire.

WM. H. DALL

SPECIAL ARTICLES

THE CALCULATION OF TOTAL SALT CONTENT AND OF SPECIFIC GRAVITY IN MARINE WATERS[1]

To the investigator engaged in biological studies on marine problems, it is often desirable to ascertain the concentration of sea-water in terms capable of correlation with life phenomena. Such concentration records usually take the form of density determinations made with some standard type of densimeter at the prevailing temperature. These density readings, while useful as physical records, are not directly adapted to physiological use. The quantity of salts present in sea-water is a term which can be so utilized and it becomes especially valuable in view of the fact that the proportion of constituents has been shown to vary but slightly, the concentration only being subject to considerable variation. By means of the *Challenger* proportions worked out by Dittmar[2] any total salt content can be resolved into its chief constituent parts. These proportions are as follows:

	Per Cent.
$NaCl$	77.758
$MgCl_2$	10.878
$MgSO_4$	4.737
$CaSO_4$	3.600
K_2SO_4	2.465
$MgBr_2$	0.217
$CaCO_3$	0.345

It has been shown that the total salt content is directly related to the specific gravity and that one may be calculated from the other. Specific gravity determinations are made with reference to different standard temperatures. Frequently density readings are made with the temperature indicated in Fahrenheit units. These are usually referred to 60° F. as a standard temperature, and the observed density is reduced to 60° F., sp. gr. 60° F./60° F. This is easily done by means of Libbey's tables.[3] If the observed temperature is below 60° F. subtract the observed degrees of temperature from 60, multiply this difference by the correction found in the table opposite the observed temperature and *subtract* the product from the reading to be corrected. If the density is observed at a temperature above 60° F. ascertain as before the number of degrees of difference

Temp.	Correction for Reduction to 60° F.	Temp.	Correction for Reduction to 60° F.
I	II	I	II
° 50	−0.000108	° 70	+0.000145
51	−0.000110	71	+0.000146
52	−0.000112	72	+0.000147
53	−0.000113	73	+0.000148
54	−0.000115	74	+0.000149
55	−0.000118	75	+0.000151
56	−0.000120	76	+0.000152
57	−0.000120	77	+0.000154
58	−0.000120	78	+0.000156
59	−0.000120	79	+0.000157
60	+0.000125	80	+0.000158
61	+0.000130	81	+0.000159
62	+0.000135	82	+0.000160
63	+0.000137	83	+0.000162
64	+0.000137	84	+0.000163
65	+0.000138	85	+0.000164
66	+0.000140	86	+0.000166
67	+0.000141	87	+0.000167
68	+0.000142	88	+0.000168
69	+0.000143	89	+0.000170

[1] Published by permission of the Secretary of Agriculture.

[2] Dittmar, Challenger Reports, Physics and Chemistry, Vol. 1, Part 1, p. 188.

[3] Libbey, William, "Physical Investigations off the New England Coast," Bull. U. S. Fish Commission, 9, pp. 397–398 (for 1889).

between this temperature and 60 degrees, multiply again by the correction factor taken from the table opposite the observed temperature and *add* the resulting product to the density reading as observed on the instrument. The table of corrections is reproduced herewith.

One frequently finds density expressed as sp. gr. 15° C./15° C. This value differs so slightly from sp. gr. 60° F./60° F. that in the following discussion the treatment applied to sp. gr. 15° C./15° C. may be understood to apply to sp. gr. 60° F./60° F. without error sufficiently large to interfere with the usefulness of any biological results in which they may play a part.

More often, however, the density is expressed in terms of 15° C. referred to the temperature of maximum density, sp. gr. 15° C./4° C. Again by the help of a correction constant determined by Dr. O. H. Tittman sp. gr. 60° F./60° F. may be reduced to sp. gr. 15° C./4° C. To make this correction 0.00082 is subtracted from the value expressed as 60° F./60° F.

When the density of a sample has been reduced to 15° C./4° C. it is possible by means of Petterson's[4] determinations to ascertain the corresponding quantity of salt in the water. This tabulation gives the specific gravity readings both as sp. gr. 15° C./15° C. and as sp. gr. 15° C./4° C. of a series of sea-water samples of different density and the corresponding number of grams of total salts per liter. This latter value was determined by the silver titration method of Forchhammer.[5] Since the sea-water varies in concentration rather in the proportion of salts present, the accurate determination of any one constituent should by simple calculation give the total salts. Since Cl is present in relatively large quantity and can be determined by titration with silver nitrate to a very great degree of accuracy, it is most often used for this purpose. It has been found by Dittmar[6] that the ratio of salt to chlorine 1.8058 applies to all oceanic waters. Petterson found a slightly greater value. He carefully determined by titration the salt content of the samples just referred to and obtained a series of values which by interpolation can be used in determining either salt content from sp. gr. or sp. gr. from salt content.

Petterson's determinations are here given.

TABLE CONTAINING THE RELATIONS OF CHLORINE, SALT, AND SPECIFIC GRAVITY

Cl_2 in ‰	Salt in ‰	Sp. gr. $\frac{15°}{15°}$ Sprengel	Sp. gr. $\frac{15°}{4°}$
19.517	35.26	1.02715	1.02629
19.415	35.07	1.02701	1.02614
19.335	34.95	1.02698	1.02612
19.171	34.64	1.02668	1.02582
18.320	33.12	1.02554	1.02468
17.040	30.83	1.02377	1.02290
17.005	30.76	1.02371	1.02285
16.277	29.46	1.02261	1.02175
15.421	27.93	1.02155	1.02068
14.220	25.77	1.01983	1.01897
12.928	23.46	1.01805	1.01719
12.628	22.93	1.01761	1.01675
12.571	22.81	1.01750	1.01665
11.263	20.45	1.01570	1.01484
9.473	17.25	1.01323	1.01237
7.067	12.86	1.00987	1.00903

Since it is somewhat awkward to interpolate observed values into this series, the writer has used the data as the basis of a generalized scheme by means of which equivalents can be promptly and easily found over a range of variation of salt content somewhat greater than has been observed at Woods Hole.[7] By plotting all of Petterson's values and by prolonging the curves, the range of the table may be greatly increased though somewhat at the expense of accuracy if an extension to either great concentration or great dilution is attempted.

In the accompanying diagram (Fig. 1) the

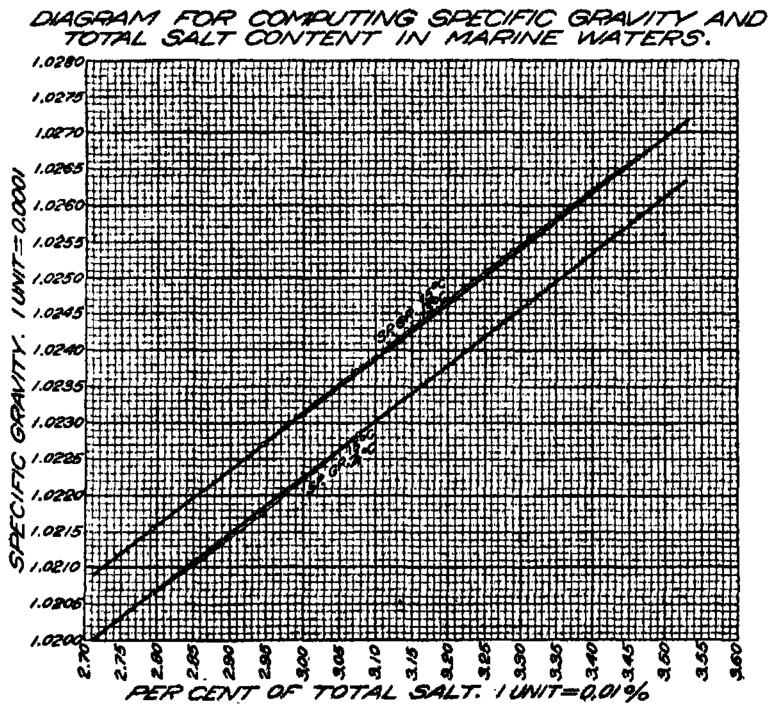
[4] Petterson, Otto, "A Review of Swedish Hydrographic Research in the Baltic and North Seas," *Scottish Geographical Magazine*, 10, pp. 296–299, 1894.

[5] Forchhammer, G., "Om Sövandets Bestanddele og deres Fordeling i Havet," Kjöbenhavn, 1859. Engl. trans. *Philosophical Transactions*, 1865.

[6] Dittmar, Challenger Reports, Physics and Chemistry, Vol. 1, 39.

[7] Sumner, Francis B., Osburn, Raymond C. and Cole, Leon J., "A Biological Survey of the Waters of Woods Hole and Vicinity," Part I., Sec. 1, Physical and Zoological, Bull. U. S. Bureau of Fisheries, Vol. 31, Part I., 53 (for 1911), 1913.

curves expressing the ratio of sp. gr. 15° C./15° C. to total salt and of sp. gr. 15° C./4° C. to the same total salt content are drawn on a scale of absolute units. The specific gravity determination made on the basis of either of the two types of reference here mentioned, is plotted on the perpendicular axis, one unit on this axis being equal to one unit in the fourth decimal place of the sp. gr. reading. On the horizontal axis is plotted the corresponding scale of salt contents, one unit on the axis being equal to one unit in the second decimal place when salt content is stated in percentage. To use the table, the sp. gr. determined either as sp. gr. 15° C./15° C. or as 15° C./4° C. is sought on the perpendicular axis. The horizontal line on which this value stands is traced to the point of intersection with the line determined for the sp. gr. ratio adopted. This point of intersection stands directly above the point on the horizontal axis at which the total salt is indicated. This can be read with approximate accuracy by reference to the nearest given values.



To determine the sp. gr. by either system of reference of a sea-water solution containing a known quantity of salts, reverse the process just described.

This diagram does not give results having a degree of accuracy required for physical investigations, but is believed to be more accurate than will be required for use in biological work. The writer had only the convenience of biologists in mind in preparing these notes.

Any one wishing to work over a wider range and with a greater degree of accuracy may use the data of Knudsen[8] in a similar way as a basis for interpolation.

For any one who is content with even rougher approximations it may suffice to apply a fairly accurate coefficient to the density readings. Karsten[9] has pointed out that when the total salt content is divided by the number represented by the first four decimal places in

[8] Knudsen, "Hydrographische Tabellen," Copenhagen, 1901.

[9] Karsten, G., *Wissenschaftliche Meeresuntersuchungen*, N. F. 1, H. I., 170, 1896.

the sp. gr. reading a coefficient is obtained which is of use in reducing sp. gr. readings to salt content. For the range of concentration likely to be seen at Wood's Hole, *i. e.*, when sp. gr. 15° C./4° C. = 1.0210 to 1.0245 corresponding to a total salt content of 2.84 per cent. to 3.29 per cent., the salt content is obtained with a probable error less than 2 in the second decimal place by multiplying the sp. gr. reading by the factor *134.5*.

RODNEY H. TRUE
U. S. DEPARTMENT OF AGRICULTURE

ON CELL PENETRATION BY ACIDS[1]

Preliminary Note

1. THE water-soluble blue pigment[2] in the cells of a nudibranch, *Chromodoris zebra* Heilprin, is a sufficiently delicate indicator to justify its use for the study of cell penetration by acids. Water extracts of the animal, containing this pigment and other cell materials expressed by grinding, change from a deep blue color with reddish-purple fluorescence to a delicate pink hue at a hydrogen ion concentration of $p_H = 5.6$[3]; the acidity of the body fluids of *Chromodoris* averages $p_H = 7.4$ (27°). The indicator promptly flocculates, in the form of a greenish-blue precipitate, leaving a blue solution, at $p_H = 7.6$. Within the epidermal cells the pigment is also turned green, so that it may be used to measure the penetration of alkalies; it gives results concordant with those obtained with a great variety of tissues by the neutral red method (Harvey[4]), and with neutral red-stained *Chromodoris* cells lacking the blue pigment.

[1] Contributions from the Bermuda Biological Station for Research, No. 39.

[2] Crozier, W. J., 1914, *Journal of Physiology*, Vol. 47, p. 491.

[3] This point changes somewhat with the age of the extract, in the case of alcohol (95 per cent.) and other permanent solutions of the pigment. The p_H values given were obtained by titration with phosphate and acetate mixtures, checked by gas chain measurements on alcohol and formalin solutions of the pigment.

[4] Harvey, E. N., 1914, Papers from the Tortugas Lab., Vol. VI., p. 133.

The pigment occurs in two forms: as granules scattered through the superficial and deeper tissues, and dissolved in clear globular bodies located within the cells of the outer epithelium, especially along the edges of the mantle and foot. It is totally insoluble in anhydrous acetone, ether, chloroform, xylol and oils. The globules containing it do not stain with fat dyes. I conclude that the pigment is held naturally in water solution.

2. Direct measurements of the speed with which acids penetrate protoplasm were first given by Harvey,[5] who determined the time required for the testis of *Stichopus ananus* to change in color when immersed in 0.01 *N* solutions of a number of acids. I have used pieces of the lateral mantle edge of *Chromodoris* in a similar way, precautions being taken to insure comparative uniformity of the pieces in the different tests, and find that *at this concentration* (0.01 *N*) the acids employed when arranged in the order of increasing penetration-time form the series shown in Table I. Comparison of this list with

TABLE I

Penetration of Acids from 0.01 N Solutions

No.	Acid.	Time, Minutes.	
		Chromodoris. Mantle Edge. 27°.0.	*Stichopus ananus*, testis (Harvey).[6]
1	Valeric (Iso-)	1.9	2–4
2	Salicylic	3.5	0.25
3	Formic	4.5	2–4
4	Hydrochloric	7.6	9–11
5	Nitric[7]	8.4	
6	Sulphuric	8.5	
7	Lactic	8.6	
8	Oxalic	8.8	12–15
9	Tartaric	13.5	30
10	Citric	16.0	40
11	Butyric	19.0	45–60
12	Acetic	75.0	

[5] Harvey, E. N., 1914, SCIENCE, N. S., Vol. XXXIX., p. 947.

[6] Only those acids which I have studied have been taken from Harvey's table, which includes a number of others.

[7] The differences in penetration-time for Nos. 5–8 are slight at this concentration, but their separation is justified on the basis of the dilution curves.

that of Harvey discloses that the relative penetrating power of the acids at this concentration is practically identical in the two cases. Some of the differences may be due to the temperatures at which the two sets of experiments were made. The figures for the *Chromodoris* tissue represent the mean of ten concordant experiments at a uniform temperature of 27°.0.

3. Examination of the penetration time of these acids over a *range of concentrations* (0.1 N to 0.001 N) shows, however, that the series established at the single concentration (0.01 N) gives an entirely misleading picture of the penetrating powers of the different acids, which is better judged by the nature of the penetration curves as a whole. According to this view the order arrived at is seen in Table II. The acids studied may be arranged

TABLE II

Penetration Power of Acids

Group I:

Acid	Ionization Constant (K)
Hydrochloric	(100)
Sulphuric	(100)
Oxalic	3.8
Nitric	(100)

Group II:

Acid	Ionization Constant (K)
Formic	0.0214
Salicylic	0.102
Valeric (iso-)	0.0017
Lactic	0.0138
Tartaric	0.1000
Citric	0.0870
Butyric	0.00149
Acetic	0.00180

in two groups on the basis of the character of their penetration-dilution curves.[8] The curves of the second group are all more or less parallel and uniformly concave toward the axis of penetration-time, whereas the curves of acids of the first group (up to 0.002 N) are from the beginning concave toward the axis of dilution. The curves of the two sets cut across one another, as do also some of the curves within each set. The acids of the first set give visible evidence of penetration at higher dilutions (n/750) than do those of the second group.

The separation of these two groups of acids is further warranted by the fact that, within certain time-limits, a preliminary exposure of the *Chromodoris* tissue to the action of acids of the second group does not hasten the penetration of acids of the first series, but does that of other acids of the second set.

4. The acids included in my group I. of Table II. are all acids of strong ionization, while those of the other group are of low acid strength. To this extent the rôle of ionization in determining permeability toward acids is made clearer than has hitherto been the case, and it seems probable that these two kinds of penetration curves represent at least two different and distinct methods whereby acids may gain access to the interior of cells. Within each of the two sets of acids the degree of ionization is less important in controlling the speed of penetration. Formic acid occupies a somewhat peculiar position, as do also butyric and valeric; the first substance shows a dilution curve more nearly approaching that of the strong acids, agreeing with its constitution, but the relative positions of butyric and valeric in the series are more likely to be accounted for by their rather high solubility in lipoids.

All the evidence so far available indicates that acids penetrate and combine to various degrees with one or more of several constituents of the cell surface. It is certain, at any rate, that the "lipoid theory" of permeability is not even approximately complete as an explanation. Further attempts to elucidate the significance of the apparently quite general uniformity in the order of cell penetrability for various acids in different animals must await the study of a larger series of substances, especially with reference to the action of acids on penetrability for other acids.[9]

W. J. Crozier

Agar's Island, Bermuda

[8] This series has an important bearing on the interpretation of sensory stimulation by acids, a matter which first turned my attention to this problem.

[9] Details, covering additional points not here considered, will be found in a paper to appear in the *Journal of Biological Chemistry.*

SCIENCE

FRIDAY, NOVEMBER 26, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ESPECIAL VALUE OF RESEARCH IN PURE CHEMISTRY[1]

MY colleague, Dr. Cattell, having considered the broad topic of the value to a democracy of research in pure science, I welcome the opportunity to take up for a few moments one of the subdivisions of his field, in order to point out somewhat more fully the especial importance of research in chemistry.

Let us, therefore, first pass rapidly in review a few of the contributions which chemistry has made or is now making to the health, happiness and material prosperity of our country, that we may be able more accurately to assess its value to the community, gain a better appreciation of the debt we owe it, and accord to it that position of high honor and dignity which is its just due.

In the reports of the Twelfth Census of the United States it is written that

> Probably no science has done so much as chemistry in revealing the hidden possibilities of the wastes and by-products of manufacturers. This science has been the most fruitful agent in the conversion of the refuse of manufacturing operations into products of industrial value. Her fairy wand has only to touch the most noisome substances, and the most ethereal essences, the most heavenly hues, the most delicious flavors and odors instantly rise as if by magic.

Whether this is a wholly overdrawn picture or not will appear in what follows.

Dealing with the ultimate constituents of our material universe, their combinations and transformations, it is chemistry that

[1] Address delivered on the occasion of the establishment of the Willard Gibbs Chair of Research in Pure Chemistry at the University of Pittsburgh, October 26, 1915.

has determined the composition of those substances which make up our own bodies, the earth upon which we live, the air we breathe, and the heavenly worlds beyond. Every particle of matter animate or inanimate acknowledges its sovereignty, for its laws govern alike the smelting of an ore, the manufacture of a complex dyestuff, or the mysterious vital processes of the living organism; and upon these laws our physical and our industrial life depend.

The transformation of the raw material into the finished product consists usually either in changing its external form, as in metal or wood working, weaving, and the like; or there is involved a chemical change, as in metallurgy, fermentation industries, the manufacture of cement, glass, soap, chemicals, etc. Our manufacturing processes are thus either mechanical or chemical, or a combination of the two.

Let us consider briefly the part chemistry plays in connection with some of the more important of these industries.

Turning first to the mineral world, it should be borne in mind that metallurgy is but one of the branches of engineering chemistry, whether it concerns the initial smelting operations or the production of new alloys for special purposes. The chemist is busily at work here, discovering ways of obtaining cheaply metals previously rare or expensive, thus inaugurating entirely new industries, as witness that of the manufacture of aluminium goods and alloys; analyzing raw materials (ore, coke, limestone, etc.), intermediate products (for many industrial operations are under chemical control at all points), and final products, such as the furnace gases, slags, and the like; improving old processes; devising new ones, particularly those which will render available low-grade or refractory ores; showing how wastes and by-products may be made valuable, the waste heat to raise steam or pre-heat the blast, and the slags for the production of cement and concrete, as fireproof packing for steam pipes, as ballast for railroad tracks, for macadamizing highways, for building purposes (as slag brick, slag blocks, etc.), or when rich in phosphorus (as those from the Thomas-Gilchrist process) for fertilizers. His success has been such in the iron industry, for example, as to lead Mr. James Douglas to remark that

> When all the volatile products of the blast furnace . . . are deprived of their heat-giving properties and their chemical constituents, and when the slags, as well as the metal, have returned their heat to man instead of to the atmosphere, and the slag itself has been turned into cement or some other useful article, it will be a question as to whether the pig iron is the principal object of manufacture or one of the by-products

It was the pioneer investigations of Bunsen and DeFaur which pointed the way for the use of furnace gases in many of the directions in which they are now so extensively employed. Another chemist, Sir Humphry Davy, by his invention of the safety lamp, has done more than any one else to protect the miner from accident and injury and, as you are well aware, the chemists of our government are now conducting experiments in this city to further reduce the loss of life and property incident to fires and explosions in mines.

Without the powerful explosives of the chemist, modern mining, modern warfare, and such great engineering projects as the Panama Canal, would all alike be impossible. After the precious metals have been extracted from their ores, it is the powder of the chemist which stands guard over them, as it does over all the accumulated wealth and property of this and other nations.

The chief source of our light, heat and power still remains the chemical combustion of some form of carbon, be it coal,

petroleum or natural gas; and chemistry again has shown how wastes may be avoided and by-products utilized. The great losses formerly permitted in the coking of coal are now being checked and the volatile products recovered, with the result that we shall soon be supplying all the benzole needed for our own home market. In the great illuminating gas industry, the by-products—ammonia water, tar and coke—are all made available by the chemist. The ammonia water is a leading source of ammonium compounds; and, as for the tar, the way in which this black, sticky, evil-smelling mass has been made to minister to the comfort and general prosperity of mankind constitutes one of the most brilliant chapters in the volume of modern scientific achievement. In the hands of the chemist, it has been transformed, as by magic, into a veritable Pandora's Box, from which may be produced healing drugs or the deadliest of poisons, delicious perfumes or the most disgusting of odors, dyestuffs of every hue of the rainbow or explosives powerful enough to annihilate this building in an instant—pleasure or pain, life or death, lie dormant there, awaiting the summons of the chemist. Then, too, chemistry has contributed the necessary mantles and filaments for modern incandescent lighting, whether by gas or by the electric current; and the calcium carbide from which acetylene gas is obtained.

A good example of the economy often accomplished by chemical research and discovery is afforded by the history of ultramarine. Many years ago when this pigment was made by powdering the mineral lapis lazuli, it sold for more than its weight in gold. Since the chemist has found how to make it from such cheap substances as kaolin, sodium sulfate and carbonate, charcoal, sulfur and rosin, the price is only a few cents per pound.

The value of our specie, upon which every commercial transaction rests, is decided by the chemist, while the green ink used in printing our banknotes, and to which they owe their name of "greenbacks," was invented by a former president of the American Chemical Society, Dr. T. Sterry Hunt.

The chemist lets nothing escape unsearched. The sweepings from the mints and from the shops and factories of workers in precious metals, as well as the water in which the workmen wash their hands, are all made to give up the gold or silver they contain. Even waste photographic solutions must disgorge their silver before they are permitted to escape.

Through the labors of the chemist, the pollution of our atmosphere by smoke, fumes, flue dust and noxious gases is being rapidly reduced; and the University of Pittsburgh is playing a prominent part in this campaign. Hundreds of thousands of tons of sulphur dioxide, formerly wasted in various quarters of the globe in polluting the atmosphere, are now, thanks to the discovery of the "contact process," annually converted into sulphuric acid, to be used for the manufacture of fertilizers, indigo and other valuable substances.

The purity of our water supply is a matter of serious concern to all of us, whether it is to be used for drinking purposes or for the industries, and both the chemist and the bacteriologist must pass upon it. The chief industrial use of water is for the generation of steam, and for this purpose the water must be free from large amounts of mineral salts, or the formation of boiler scale will proceed rapidly. So that, even in such a fundamental engineering operation as steam-power generation, the engineer must first consult the chemist as to the quality of the fuel and water he expects to use. The loss due to locomotive boiler scale alone in the United States has been esti-

mated as equivalent to fifteen million tons of coal per annum. Chemistry has also rendered yeoman service in reducing the pollution of our streams and coastal waters, by showing how many of these wastes may be converted into valuable commercial products, and more money be made in this way than by dumping them into the streams.

In those operations in which pure water is indispensable, the cost of impure water is the cost of purification, and it is to the chemist that the manufacturer must turn for instructions as to how this purification may be accomplished best. Impure water means additional cost of production, not only to the steam-power plant, as just mentioned, but also in paper-making, straw-board mills, brewing, distilling, ice manufacture, bleacheries, dye works, canning and pickle factories, creameries, abattoirs, packing-houses, factories for explosives, sugar, starch, glue, or soap, woolen mills, tanneries and chemical works, as well as in many other lines of industry.

Agriculture still remains the world's most important industry, as nearly 36 per cent. of our people are engaged in it, and all the rest depend upon it. Mr. James J. Hill has said that

> In the last analysis, commerce, manufactures, our home market, every form of activity runs back to the bounty of the earth by which every worker, skilled or unskilled, must be fed and by which his wages are ultimately paid.

And Liebig, in the preface to his great work on "Chemistry in Its Applications to Agriculture and Physiology" calls attention to the fact that

> a rational system of agriculture can not be formed without the application of scientific principles, for such a system must be based on an exact acquaintance with the means of nutrition of vegetables, and with the influence of soils and actions of manure upon them. This knowledge we must seek from chemistry, which teaches the mode of investigating the composition and of studying the character of the different substances from which plants derive their nourishment.

In this great domain, the services of chemistry include the fixation of atmospheric nitrogen, the elucidation of some of the ways in which atmospheric nitrogen enters into organic combination and of the methods whereby organic nitrogen is prepared for plant food, the analysis of soils and the determination of their relation to plant growth, the analysis of plants and agricultural products and a study of the influence of environment upon their composition, the manufacture of fertilizers and their adaptation to the needs of different soils and crops, the protection of the farmer from fraud when he purchases the same, methods of utilizing plant food and of conserving it for future use, the establishing of the general principles of plant growth and the chemical changes involved, the replacing of natural dyes and drugs by synthetic articles, the manufacture of artificial silk and the saving of the natural silk industry from threatened obliteration, the production of other artificial fibers and fabrics, the mercerization of cotton, the manufacture of substances to take the place of resins and shellac, the rescue of crops from impending destruction by providing effective insecticides and fungicides, the production of valuable substances from former wastes (cottonseed oil, corn oil, gluten from starch factories, cream of tartar from wine lees, and the like), and of industrial alcohol from crop refuse. Dr. H. W. Wiley has expressed the opinion that

> The application of the principles of chemical technology to the elaboration of raw agricultural products has added a new value to the fruits of the farm, opened up new avenues of prosperity, and developed new staple crops.

The introduction and enactment of our Pure Food and Drug laws, as every one is aware, were due primarily to the tireless activity of this same chemist.

It probably has not occurred to the layman that the chemist might appear also in the rôle of a land reclaimer, and yet the discovery of commercially profitable methods of manufacturing alizarin and indigo from coal tar has set free for other crops hundreds of thousands of acres formerly devoted to the raising of madder and indigo.

In the realm of animal industry, the chemist has elucidated the laws of animal nutrition and taught the farmer how to adapt his feeding-stuffs to the needs of his stock, so as to secure the maximum return in work, meat, fat or milk, and by analytical control again protects him from fraud when he buys his cattle feed. When diseases attack the herd, chemistry supplies antiseptics and powerful remedies of all kinds. Not so many years back, it was the custom to build slaughter houses on the banks of streams into which all the refuse was turned. But chemistry has revolutionized all this, and the old joke about the Chicago packing-houses using every part of the pig, including the squeal, is now not far from the truth. In modern abattoirs and packing-houses, the hides are used for leather; the grease is converted into soap, candles, oleo and glycerol (for nitroglycerin manufacture); the blood and scrap into blood albumen, fertilizers and potassium cyanide (for gold extraction, among other uses); the horns and hoofs into jelly, buttons, knife handles, etc.; the feet, bones and heads, into glue, bone oil and bone-black. The skim-milk formerly wasted, now surrenders its casein, from which so many interesting and useful articles are manufactured. Chemistry has also provided a number of satisfactory leather substitutes, while the waste from real leather is converted into fertilizer or glue.

It is chemistry again which has put into the hands of the builder non-combustible building materials, such as iron and steel, cement, brick, plaster, terra-cotta, tiles of all kinds, porcelain, pottery, stoneware and earthenware, and all kinds of metallic furnishings and fittings; fireproofing solutions for the safeguarding of combustible materials; paints and varnishes, to protect from weathering and decay; preservatives to prolong the life of the timber and ward it from the attacks of marine borers, molds and fungi.

Formerly all the alkali required for soap manufacture was derived from wood ashes; but the chemist has shown how it can be secured much more economically by the electrolysis of common salt.

In addition to all this, and much more which could be cited, it is chemistry that provides a majority of our most potent anesthetics, antiseptics and remedies of various kinds. In his fight with disease and death, the physician has no more powerful or resourceful ally than the chemist. Finally, the processes of the living organism, plant or animal, are primarily chemical, and instead of the formation of organic compounds in the living organism being longer referred to a mysterious "vis vitalis," the question has lately been raised seriously as to whether life itself is not merely one of the products, or the resultant, of a definite series of chemical reactions. Dr. Schaefer, in his presidential address before the Dundee meeting of the British Association for the Advancement of Science, after calling attention to the comparatively few elements and simple compounds of which living matter is composed, said "The combination of these elements into a colloidal compound represents the chemical basis of life; and when the chemist succeeds in building up this compound, it will without doubt be found to exhibit the phenomena which we are in the habit of associating with the term 'life'"; and he fur-

ther suggests "that heredity also is one of the questions the eventual solution of which we must look to the chemist to provide."

I like the old familiar concept of the human organism, not as an individual but as a community, a humming, bustling hive of industry, where each separate cell has its own special kind of work to perform; some splitting up the raw material as it is received into simpler substances and classifying these for transmission to other cells, where they are built up into materials necessary for the life and development of the organism; some cells carrying on a process of benevolent assimilation, others "doing an illicit still business"; with the great central pumping station driving life and energy to the remotest corners of the establishment. That is not only the most fascinating organic chemical laboratory in the world, and its most important chemical industry; but it is also the one which concerns us most intimately. Whether we live or die within the next five minutes, depends absolutely upon whether the reactions now going on in all the minute organic laboratories of our bodies continue in their normal healthy course or suddenly go wrong.

Chemistry has been well characterized as "the intelligence department of industry." It does not skim the cream of other men's labor, but is itself so great a creator of national wealth that the actual money value of its services is beyond computation.

In this brief and very superficial fashion, I have endeavored to give you some idea as to what chemistry means to our present-day civilization. All of these remarkable achievements are but the outcome of patient and painstaking research in the field of pure chemistry. Investigations in pure science laid those broad and deep foundations upon which applied science has erected the wonderful structure of modern industrial operations. Small wonder, then, that the establishment of a chair of research in pure chemistry is a cause for gratification and encouragement.

No one can tell at what instant some observation recorded in the course of a research may suddenly become of immense importance. When Cavendish, 130 years ago, read a paper before the Royal Society describing the formation of nitric acid by the passing of an electric spark through air, it certainly never occurred to any one present that the question of the fixation of atmospheric nitrogen might one day prove the means of saving the human race from starvation, and yet such may turn out to be the case in the years to come. Perkin had no intimation that the experiments conducted during the Easter vacation of 1856, in the effort to obtain quinine synthetically, would result in a billion dollar world industry in coal tar dyestuffs; nor could Bessemer have foreseen that his process would one day save the world over two billion dollars annually.

The nineteenth century has been described as the Age of Physics and Engineering, since it witnessed such triumphs as the development of steam and gas engines, and the utilization of electricity as a source of light, heat and power, and as a means of communication. The twentieth century will quite certainly be an Age of Chemistry. Germany realized this some years ago, with results that are now evident to all.

If we would not be left far behind in the race, we must pursue a similar course, and that at once. We have yet to convince many of the nations of the earth that the form of government in which we believe, and to establish which our ancestors died, is the best not only for the freedom and happiness of the individual, and the development of the noblest intellectual and moral standards, but also for the growth of the country in physical strength and resource-

fulness, and that in the hour of need it will not be found wanting in the vital matter of industrial efficiency and solidarity which is the corner-stone of all military power.

In the terrible world war now raging, the law of the survival of the fittest will be found as inescapable, immutable and inexorable in the case of nations as it is with individuals. It listens to no explanations, accepts no excuses, and knows absolutely no pity. Our own country is beginning to awaken to the fact that civilization unarmed by science is at a terrible disadvantage in the event of a struggle for existence, and that this arming can not be done at short notice. The result is a loud and urgent call upon the universities, colleges and technical schools of the land for help.

Conspicuous among those answering this call most effectively are the University of Pittsburgh and its Mellon Institute. Conducting an energetic campaign for the education of the community to a better appreciation of science, pointing out to the manufacturers wherein the chemist can aid them, and winning their support for chemical research, prosecuting skilful investigations directed to the immediate public needs, and turning out highly-trained scientists, this university has already made an enviable record of service, and has placed under a lasting debt of gratitude not only the city of Pittsburgh, the chemical profession and the nation, but the entire world of humanity as well; for its activities minister in the highest degree to the progress of civilization, and its achievements ultimately become the property of all mankind.

Robinson has defined education as "the process of fitting the individual to take his place and do his part in the life of his age and nation," and no educational institution at the present time can discharge this responsibility faithfully unless it accords, in its equipment and in its curricula, adequate recognition to so comprehensive a science as chemistry which, in its wide sweep, touches almost every phase of human life and endeavor.

Two years ago, in an address which I had occasion to deliver in England, I ventured the opinion that the most pressing need of the day was the proper endowment of chemical research, by the founding of great research institutes and the creation of research professorships. That opinion I have not altered.

The establishment in this university of the Willard Gibbs Professorship of Research in Pure Chemistry is an occasion for warmest congratulations: to the chancellor and trustees of the university on the momentous step they have taken in the direction of building up a great new school of graduate and research work in pure chemistry; to the distinguished director of the Mellon Institute, Dr. Raymond F. Bacon, for his wise foresight in securing such a department as a powerful means of advancing progress in industrial research; to the university and its Mellon Institute, on securing as the first incumbent of the new chair a most talented teacher and investigator, Dr. Martin A. Rosanoff, whose researches have already won for him an international reputation; and to Professor Rosanoff himself, on being selected for this high honor.

That this new chair should bear the illustrious name of Josiah Willard Gibbs is peculiarly appropriate, for, as an investigator in the field of pure chemistry, Ostwald has called him "by far the greatest scientist America has yet produced," and Le Chatelier has said that his work marks an epoch as important as that of Lavoisier. Abstruse and recondite as those researches were, their fundamental bearing upon the development of our science is daily becoming clearer.

In felicitating the chancellor and trustees, it is not necessary to point out that a university's greatness is not determined by the magnificence of its plant, its athletic prowess, or the size of its student body, but by the number and importance of its graduate schools; and that the standing of a graduate school, in the judgment of those whose opinion is really worth having, is measured by the amount and quality of its output of genuinely original investigation. The extent of the assistance which a university secures from its surrounding community in the creation of such splendid graduate schools as we see here, is not infrequently the reflection of the attitude of the university authorities themselves toward such work; and the city of Pittsburgh is indeed fortunate to have at the head of its famous university a chancellor and trustees who know how to prize original scientific investigation at its real worth, and under whose fostering care and guidance it is certain to have full opportunity for development.

To the staff of noted teachers and investigators already connected with this university, Dr. Rosanoff has been called, and I bring to him the congratulations of our chemical department at Columbia and our best wishes for a long, happy and useful career.

He is an unusually gifted man—chemist, physicist, mathematician, linguist—and intends to devote his versatile talents to the difficult, but very important field of physico-organic chemistry. He should be a very happy man to-night, for I know that it has been his ambition to be permitted to devote his life to research in pure chemistry, and happiness has been defined as the quotient obtained by dividing our ambition by our achievements. There is no doubt that he will do all in his power to widen the boundaries of knowledge in his chosen field, and that he will succeed, through his own labors and those of his junior colleagues, research associates and students, in bringing honor and prestige to the chair.

I would gladly explain to you the importance of the numerous discoveries he has already made, but time does not permit, and much of it, I fear, would be about as fascinating to the uninitiated as an attempt to expound the fine points of Sanskrit syntax.

Accordingly, I will limit myself to a few of his more notable contributions.

Fractional distillation is an ancient process, but it has remained largely an empirical one. True, its practical applications have developed and experience has shown the particular value of various forms of distilling apparatus, but the underlying theory has continued more or less in dispute and it has been impossible to calculate accurately in advance the correct arrangement of the distilling heads necessary to realize a maximum separation of the components of a liquid mixture; the only way to find out having been to assemble an outfit and make a trial run. Professor Rosanoff's studies of the problem have convinced him that the conclusion arrived at by previous investigators to the effect that a single regulated still-head sufficed to separate completely binary mixtures was not in accord with the facts. By an application of the theory of partial vapor pressures he has corrected this error and shown that not one, but a series of still-heads is necessary, the temperature of each of which bears a definite mathematical relation to that of every other one. This has been experimentally confirmed very many times during the past three or four years, and it would appear that research in pure chemistry has at last placed this age-old process upon a firm scientific basis. The American Chemical Society recognized the fine quality of

the work by awarding Professor Rosanoff its Nichols Medal for the year 1910. As distillation plays a very prominent part in many of our leading industries, the importance of the investigation requires no comment.

Other valuable researches conducted by Professor Rosanoff had to do with such well-known generalizations as the theory of electrolytic dissociation and the law of mass action. In the case of the hydrolysis of sucrose, and the decomposition of tertiary amyl esters, other investigators have reported results which were at variance with one or both of these hypotheses, and the consequence has been increasing confusion and perplexity. By long-continued study of these problems, on the part of his colaborers and himself, Dr. Rosanoff has proved both mathematically and experimentally that the observations primarily responsible for this troublesome condition of affairs were inaccurate and misleading, and that the theories of electrolytic dissociation and of mass action are beautifully confirmed in these particular cases also. To bring order out of chaos is indeed a welcome service. The "hydrolysis of sucrose" probably sounds highly technical to the layman, but it is a chemical reaction upon which depends the evaluation of the entire sugar output of the world. As our country has something like three hundred million dollars invested in the sugar business, the problem obviously has its practical side as well.

All of his work has been characterized by the refinement and precision of the physico-chemical measurements made, the painstaking and laborious efforts to eliminate all possible sources of error, and the immense number of experiments carried out before any conclusions are drawn.

In the coming years, I can wish for him no higher reward than that he may succeed in communicating to his students some of his own contagious and enthusiastic love of the subject, since this is the greatest been in the gift of any teacher and the one which brings most happiness to the donor. With that compelling inspiration, the student will get the dry facts of the science in due time; without it, knowledge alone can never make him a really great man.

For his comfort, I would remind my colleagues of the words of Epictetus:

> Remember that such was, and is, and will be the nature of the universe, and that it is not possible that the things which came into being can come into being otherwise than they do now; and that not only men have participated in this change and transmutation, and all other living things which are on the earth, but also the things which are divine. And indeed the very four elements are changed and transmuted up and down, and earth becomes water and water becomes air, and the air again is transmuted into other things, and the same manner of transmutation takes place from above to below. If a man attempts to turn his mind toward these thoughts, and to persuade himself to accept with willingness that which is necessary, he will pass through life with complete moderation and harmony.

I am confident that he will never become so deeply engrossed in his researches as to lose sight of the main purpose of all education, which is to make better men and more useful citizens; and that his efforts will always be directed to training men to be not only great scientists, but also great Americans, and that in so doing he will not fail to impress upon each student that the individual is but one of the players in the mighty drama of human life and endeavor, and that he should therefore play his part worthily, as owing a debt both to his profession and to the community in which he lives. "What art do you teach, Protagoras?" asked Socrates. "I teach the art of citizenship," replied the sophist. "Then, indeed," said Socrates, "you teach the noblest and best of all arts, for it includes all others." And Epictetus writes:

You will do the greatest service to the state, if you shall raise not the roofs of the houses, but the souls of the citizens; for it is better that great souls should dwell in small houses than for mean slaves to lurk in great houses.

After all, it is the development of genius that is most important for the progress of the world. The lives of such men as Faraday, Liebig, Pasteur, Williard Gibbs, are of inestimable value to mankind. Though these men themselves have lived their little day and passed on, their work is immortal; and it is certain that many of the investigations carried out in the laboratories of this splendidly equipped university will still shine with undimmed luster long after these noble buildings have crumbled in decay.

The pyramids that cleave heaven's jewelled portal;
  Elean-Jove's star-spangled dome; the tomb
Where rich Mausolus sleeps—are not immortal,
  Nor shall escape inevitable doom.
Devouring fire and rains will mar their splendor;
  The weight of years will drag the marble down;
Genius alone a name can deathless render,
  And round the forehead wreathe the unfading crown.

MARSTON TAYLOR BOGERT
COLUMBIA UNIVERSITY

THE TEACHING OF THE HISTORY OF SCIENCE

ITS PRESENT STATUS IN OUR UNIVERSITIES, COLLEGES AND TECHNICAL SCHOOLS

THE significance and merit of the present investigation, while of great interest to the author, remains for those actively engaged in the work of teaching to determine. It is only recently that any great indication of a change in method in science teaching in our higher institutions has been manifested. They have found that "science," as a means of education, assumes a broader aspect in courses upon the history of scientific progress—such as those originated by Harvard University and the Massachusetts Institute of Technology. Proof of the coming change can be seen in the character and number of critical reports and articles appearing in the various scientific and educational journals. For those who seek further enlightenment, a short bibliography will be found appended.

This paper is divided into two parts, namely, the arguments regarding the intrinsic value of the history of science as a study and as a factor in educational efficiency. These arguments are supported by citations from erudite men, active in the promotion of scientific training. The second division contains facts, tables and other material necessary to show the present condition and trend of the subject, and if possible to validate the arguments upon the value of a course in history of science as a whole, over courses in the more specific fields—as the history of chemistry, or astronomy, etc.

I

The discussion centering about a course which should give some idea of the history of science as a whole is of comparatively recent date, at least in this country. It arose in the demand of a small body of progressive scientific men for a study that would give our students (scientific and technical) something more than mere facts, theory and technic, in solving problems. We have heard too much of the orthodoxy of science, its over-specialization, and (as one of our foremost philosophers has put it) a certain amount of crudeness and pettiness in our methods and opinions concerning problems in science—at least in comparison with European scholars.

During the last decade of our scientific progress there has come about a development and reaction from the extreme and powerful method of specialization, both in methods of research and in teaching, whereby stress is laid upon the cultural and broadening effects in scientific study—the learning of principles and not mere facts. One factor in this development, though not seemingly important in the past, is now demanding its full recognition, the *teaching* of science from the *historical* point of view, not entirely from the economic or problem-solving reasons—the historical development of the principles, the evolution of science itself, showing correlation and interrelation between the most simple and the most

complex concepts. This then may be assumed to be the purpose and intent of the study of the history of science, or as Dr. H. C. Brown, of the philosophy department (Stanford University), states it, it shows a growing recognition of the value of mind. Intelligence was a plaything for the ancients, a consolation for the medievals, but an instrument for the modern.

In the words of Dr. C. R. Mann, of the University of Chicago:[1]

One immediate consequence of this sort of historical study would be the much-desired humanizing of science, for we should be compelled to recognize the various ways in which science has cooperated with the other phases of human activities in bringing us into our present condition.

The theory of Dr. Wilhelm Ostwald[2] is that "the history of the sciences offers the best and most authoritative material for the study of law in the evolution of mankind." Further, as Professor Ostwald sees it, the history of science is not merely history for its own sake, but a new method of study, a new way of getting at the results of research.

From John Fiske in his study of evolution as a method of study,[3] we find these precepts:

Study the present in the light of the past. The easy work of science is mostly done. Those who would continue work must study, not living objects, but laws that govern them. Whether planets or mountains or molluscs or subjunctive modes, or tribal confederacies, be the things studied, the scholars who have studied them most fruitfully were those who have studied them as phases of development. Their work has directed the currents of thought.

Ostwald[4] emphasizes the importance of historical study as an interpreter of the interrelationship of science and life:

The nineteenth century was too full of creative work in the various fields of science to give historical studies their full play. The new century, on the other hand, though it has achieved already some very remarkable results in the way of positive additions to our knowledge of the forces of nature, will offer a larger field for historical studies, for the reason that the practical value of such studies will be more clearly demonstrated. The author deprecates the idea that pure science can have no connection with life. The great investigators, he says, "were almost without exception in their younger days passionately enthusiastic over some concrete, practical aim, and it was in the course of the further and higher development of these problems (which indeed followed rapidly upon one another) that they themselves attained a wider and higher point of view. The tree of knowledge raises its crown high in the ether of pure science, but it is rooted in the firm ground of human needs and activities.

Pres. Henry S. Pritchett,[5] after discoursing upon the progress of science in past ages, and especially upon the larger aspect of science from the middle of the nineteenth century to the beginning of the twentieth, brings out the fundamental contrasts which stand out most prominently:

First, the last fifty years have seen a greater betterment of the theoretical basis of physical science. Second, this development has been marked by a notable stimulation of scientific research, a differentiation of scientific effort, and the creation thereby of a great number of special sciences or departments of science. Third, the possession of a secured theoretical basis and the intellectual quickening which has followed it have resulted in the application of science to the arts and to the industries in such measure as the world has never before known. These applications have to do with the comfort, health, pleasure and happiness of the human race, and affect vitally all the conditions of modern life. Fourth, perhaps in many respects the most significant of all, is the effect which has been produced upon the religious faith and the philosophy of life of the civilized world by the widespread introduction of what may be called the modern scientific spirit.

Lastly, here we may add perhaps the most fundamental principle, which should also be vital indeed in the purpose of the study of the

[1] "The History of Science, an Interpretation," *Pop. Sci. Mo.*, April, 1906, Vol. 76.

[2] See introduction to his book, "Die Entwicklung der Electrochemie."

[3] Quoted from excerpts in Dr. D. S. Jordan's "Syllabus on Evolution," 1895, pp. 4–5.

[4] Quoted from a review of his book, "Die Entwicklung der Electrochemie" (Leipzig, J. A. Barth), in *The Nation*, Vol. 90, p. 637, June 23, 1910.

[5] *Atlantic Monthly*, November, 1907, p. 614.

history of science—namely the development of the scientific concepts or ideas (see Ostwald's "Naturphilosophie") and the methods evolving such.

Up to the present time the range and domain of science includes all that is of nature, and from her the four great interrelating principles have been evolved. Manifestly, they are well known, but for contemporary testimony they will be restated. Dr. W J McGee[6] has termed them "the four cardinal principles of science—namely, the indestructibility of matter, the persistence of motion, the development of species, and the uniformity of nature." The philosophy of each of these accepted doctrines is the history of science.

It is interesting at this point to note the following ideas from a powerful article by Dr. J. F. Woodhull:[7]

> Culture courses, or information courses, are often spoken of scornfully as a smattering of all the 'ologies.
>
> Science culture differs in its methods from the old classical culture, but it has the same spirit and same object.
>
> The weakest thing about our research to-day is that our men are not widely informed.
>
> Davy, Faraday, Tyndall, Pasteur, Humboldt, Huxley, Maxwell, Agassiz, Cooke, Shaler, Newcomb, all preached the doctrine that science is good for culture and should be given to all.
>
> Value scientific courses—not simply because they cultivate the perception and reasoning faculties, but because they fill the mind with lofty ideals, elevated conceptions and noble thoughts; indeed there is no better school in which to train the esthetic faculties of the mind—taste and imagination—than the study of natural science.
>
> The history of science tells of a multitude who have worked in faith for the love of knowledge, and made themselves and their fellows more noble men.

The history of science is referred to here as including all the divisions of pure science, not emphasizing one over another, nor one apart from another (as, for instance, physical and biological). No matter what particular specialty he chooses, the whole field of science is to the student of science vital and important. In this manner its history will comprehend what relations exist between the development of the various subjects in various periods, the correlation of these divisions and their advances, the problems of science, and lastly, the evolution of the sciences, all will be to him an intellectual pleasure and a noteworthy part of his training and education.

II

The problem this paper is attempting to consider is twofold: First, to show somewhat the historical development of these courses in the history of science; second, to argue that although a course in the history of a specific subject may be desirable, it does not possess the value and merit in education that a strong and well-developed general history of science has. It will be also shown that such a course is the most economical in regard to time, service to the university authorities, and service to the student. Various single courses can be combined and correlated, to make one course (general) for 3 or 4 hours throughout the year.

In America the early history of the development of the science instruction in our higher schools is one certainly important, and possessing interesting characteristics; and the history of the courses upon the history of science—general and specific—has had almost a parallel treatment.

The early development of this movement can be traced from the crude materialism of the older physicists in Europe, to about 1880. In the following few years the period of overspecialization was coming to a climax, and with this, an undercurrent of idealistic and critical tendencies in scientific thoughts was being manifested. Probably the first conscious indication of interest in the history of science dates back to 1883, when "Die Mechanik in ihrer Entwickelung, historisch-kritisch dargestellt," by Dr. Ernst Mach, first made its appearance, followed by Karl Pearson's "The Grammar of Science" (1892) and in Germany by Dr. Wilhelm Ostwald's "Naturphilosophie." In France Henri Poincaré's work

[6] Washington Academy of Science *Proceedings*, Vol. II., pp. 1–12, 1900.

[7] "Science for Culture," *School Review*, Vol. 15, p. 123, February, 1907.

has its influence and bearing, and in Italy Anton Favaro.

Out of this critical-idealistic tendency to react from the materialism of science grew the idealistic-historical movement. This is sometimes thought of as the synthetical and generalizing phase in scientific learning. The effect of that movement in this country was slight at best, but a beginning had been made in Harvard University by Dr. Richard in 1890, and in the Massachusetts Institute of Technology by Dr. Sedgwick and Dr. Cross, somewhat earlier. Dr. Richard's course was a series of voluntary lectures upon chemical philosophy, but it was virtually a course upon the history of chemistry. Later, receiving official recognition, it changed to its present title—historical development of chemical theory and elementary physical chemistry. From this grew out (1911) the present courses in the history of the physical and biological sciences given by Dr. L. J. Henderson.

The development of the courses by Dr. Sedgwick had somewhat similar progress. In 1887 he offered a course of twelve popular evening lectures upon the history of biology; later this was transferred to the regular institute curriculum, and became known as the history of the natural sciences. Also in the same year Professor Cross gave to the seniors a reading course on the history of the physical sciences, requiring French and German as well as elementary physics and laboratory work as prerequisites. It was not until 1905 that these courses were combined and given as a regular course called history of science—offered by Professors Sedgwick and Tyler.

In 1879–80 at Johns Hopkins University a course of twelve lectures upon the history of chemistry was given, but in such a manner that it has never been considered a regular and definite course.

An interesting fact, again manifested here, is that most of our pioneering in intellectual activities inevitably has its origin in the older New England institutions. To Harvard University belongs the credit of first establishing a definite and systematic course in the history of a special field in science, and to Massachusetts Institute of Technology, the recognition of the more general field in the historical work in science. That the authorities of Harvard have fully recognized the value and purpose of this new advancement in science teaching, is revealed, not alone by the establishment of the history of science as an independent "group" in their curriculum, but in doing something of a missionary character, as well. This is a very notable instance in educational progress. Dr. L. J. Henderson was, during the past semester, the exchange professor to five middle-Western colleges—Beloit, Carleton, Colorado, Grinnell and Knox. At each of these institutions he gave a course of twelve lectures upon the history of science. The order and sequence in which they were established and given are excellent, and therefore a copy of the lecture-series is here added:

1. What is Science?
2. Ancient Astronomy and Its Importance.
3. Ancient Physics.
4. Ancient and Modern Science.
5. Harvey and the Renaissance of Biology.
6. Galileo to Newton, and the Renaissance of Mechanics.
7. The Seventeenth Century.
8. The Eighteenth Century.

9-10. The Great Synthesis of the Nineteenth Century.

11. The Industrial Revolution and the Scientific Revolution.
12. The Value of Science.

Having now shown in brief what the beginnings of this movement were, it will be of further interest to trace it through the few other schools to the present. We are still to bear in mind that the specific courses *only* are being considered; the general history of science courses are of late origin, and exist only in a few schools. The response to this new phase of science instruction was slow, in many cases irregular, and in some cases indifferently considered. This fluctuation is only apparent in the older schools in the early period—as, for instance, when the history of astronomy was once given, it is now discontinued, and *vice versa*. In 1892–93 Yale University first offered a course in the history of mathematics

and in astronomy; both were discontinued, and to-day there is established a course in the history of biology. The University of Chicago likewise in the same year announced courses in the history of astronomy and of chemistry, but several years later these were discontinued.

The effort to keep up this work at the University of Chicago has never ceased, however; we find the history of physics and of geology offered, as well as a course in the history of geography (which of course is not a pure science subject). At the same university the scientific faculty attempt to institute a very unique and ambitious plan for the fostering and development of the historical courses in science. A letter from Dr. F. R. Moulton explains it:

> The department of philosophy was to initiate the system by giving an introductory course in Ancient Science, developing it to about Galileo's time. From here the following departments (mathematics, physics, chemistry, astronomy, biology and geology) were to carry over the modern period of science in their particular fields.

These courses were to be correlated, and so given as to form a large and orderly sequence in the history of science. The one difficulty in the scheme, Dr. Moulton writes, is that it was impossible to get the same students to continue throughout the year; and worse still, the methods of the different professors were so diverse that there was really no continuity in the discussion. The plan has now been abandoned. But for a substitute there has been developed an excellent series of courses by Dr. G. H. Mead in the philosophy department, on a closely allied subject—the history of the ancient and modern scientific concepts.

In time a number of other schools followed—Universities of Pennsylvania, Cornell, Illinois, Michigan, Northwestern, Stanford and California. This response was felt to be necessary in the west as well as in the east, and California and Stanford have maintained it consistently. From 1895 to date a course in the history of chemistry has been offered at the University of California, with slight and varying degree of success. In the department of astronomy from 1896 to date, the historical course has been found to be in greater demand, whereas the history of mathematics was given only for a period of three years. Stanford University has, from the time of its foundation (1891), offered a course in the history of chemistry almost continuously, except that of late it has been given in alternate years. The course in the history of physics has been abandoned. Instead, however, a "Journal" course is given with the same idea, *i. e.*, discussing certain epoch-making problems in physics, from the historical point of view.

A further study of the individual colleges and universities will reveal a like condition regarding the changeable character of historical studies in the science departments, and the reasons for this are many, apparent to the individual schools themselves; namely, lack of students, lack of interest, improper correlation and requirements, and no ideals of what constitutes true breadth of culture and efficiency in scientific training. A very noticeable and astonishing neglect exists in a number of our larger schools, in which one naturally would expect greater efficiency and continuity. They omit entirely the historical treatment of some of their strongest scientific departments. A historical course should certainly be given in the departments where some degree of strength and prominence has been attained. California and Michigan in astronomy, Harvard in chemistry, Chicago in physics and mathematics, have carried this idea out partly.

A study of the conditions in smaller schools is naturally not very different from the larger, except in the total number of courses offered, as well as the types, which center around the physical sciences.

In order to obtain a scientific account of the present trend of the historical courses given, a statistical study was first undertaken, which was divided into three parts by grouping the universities, colleges and technical schools.[6] There are about 600 higher institutions of learning in the country, and it was found impractical and unwise to use the entire number for this particular study. It is also untrust-

[6] Selected from the Report of U. S. Commissioner of Education, 1913, Vol. II., pp. 198–209.

worthy, for comparative study, to segregate universities from colleges. Therefore some means of standardizing was resorted to, in order to eliminate schools having no concern in the discussion, such as theological seminaries, trade schools and preparatory schools. The problem was very much simplified by rating the efficiency and high educational qualities of a school, not by numbers in registration, but by the quality and type of instruction, the work given, and by library facilities and accessions. The first element was easily determined by using the accepted list of schools, as passed by the Association of American Universities for the Prussian Kulturministerium.[9] These schools will be known as the association group. The second group is the library standard group, containing colleges whose library accessions are over 10,000 volumes. The reason for making this limit was that equipment and not large student body was to determine the strength of the school. A school of from 300 to 500 students and library of 5,000 volumes did not compare with a school of from 200 to 400 students and 10,000 volumes. The third division will be called the technical group, composed of about 50 of the technical, agricultural and mechanical arts colleges.

At best, these three groups are arbitrary divisions, but they will serve the purpose of this study.

Of this list of over 600 schools, more than 500 catalogues and college curricula were examined thoroughly, and the information desired was found in some 350 catalogues, of schools conforming with the above restrictions. In all cases the information was taken from the latest catalogues—either 1914–15 or 1915–16—except in a few instances. The facts searched for are as follows:

(*a*) Type of historical courses—general, physics, chemistry, etc.

(*b*) Hours of lectures, whether given in one semester or both; or alternate years.

(*c*) Graduate study and requirements for "majors" in departments.

[9] See *Educational Review*, December, 1913, p. 510–518.

(*d*) Other facts bearing upon this discussion.

The arrangement of the statistics gathered together in this paper is for the purpose of showing what each institution is doing. One can, for example, see at a glance what work is offered at Chicago or Harvard, and compare it with courses in other institutions. While this study is as scientific as it was possible for the writer to secure reliable data, it must be taken with some consideration of the probable errors existing. It was found in at least four to six cases, through special correspondence, that a number of courses were offered in the catalogues, but not actually given for various reasons. Another interesting fact regarding these figures, which on first assumption might indicate a definite policy of the colleges concerned, and one which parallels with the attempts of the University of Chicago plan, is that there appears to be a continuity in some of these courses, which in reality does not exist. For example, a college may offer a series of three or four history courses in the specific sciences; these are not correlated, and they are not completed by courses of the same type in the remaining sciences. The schools having this apparent arrangement of continuity of courses (see Table III.) are Alleghany, Carleton, Columbia, Iowa State, Mt. Holyoke, California, Illinois, Michigan, Pennsylvania and Pittsburgh. The criticisms of such a continuity are well sustained by Professor F. R. Moulton. However, a small college may succeed in this where it is better adapted to alternate its courses. If this could be accomplished, no doubt there are educational factors of merit in such a system, that are not to be had in a single general history course—namely, a more comprehensive treatment of the special subject, and a study of the development of its theories and technic.

Table I. is an analysis of the data gathered from the principal or association group. The subject-matter is arranged for a comparative study of courses, hours of lectures, and class enrollment. Column one contains the list of nine subjects comprising pure science, technically speaking; column two, the total num-

ber of courses in each subject in this particular group; in three and four are the number of half and full courses offered (column two is the sum of both); column five contains the total number of hours devoted to lecturing or instruction, and in six and seven are the average number of hours per course and average number of students per course.

TABLE I

Group Ia (Association Standard)—113 Schools

Subjects	Total No. Courses	½ Semester Courses	Full Yr. Courses	Total No. Hrs. of Instruction.	Average No. Hrs. per Course per Wk.	Average No. Students per Course
Math.....	47	27	20	113	2.4	14
Physics ..	19	10	9	31	1.6	7
Chem....	38	17	21	74	1.9	13
Astron. ..	13	11	2	33	2.5	9
Geology..	4	4	—	12	3.0	3
Biology ..	14[10]	6	8	28	2.0	8
Botany ..	4	2	2	12	3.0	2
Zoology..	17[10]	17	—	36	2.1	—
Psychol. .	6	6	—	16	2.6	—
	162[11]	100	62	355	2.3	8.0
General history of science	14[12]	9	5	30	3.0	51.0

In the total number of courses offered in the 113 schools, two subjects stand out more prominently than all others—mathematics and chemistry. The explanation of this condition is to be found by a study of the catalogues of courses themselves and of the answers to questionnaires sent out. The subjects reveal two differing points of view, though both are, apparently, desired by students.

In the case of mathematics, the large number of courses offered is due to the fact that the teaching methods (especially those for the elementary teacher) are taught in combination with the history of the subject. The largest class enrollment in the history of mathematics is found to be at Teachers' College, Columbia University; it is given by Dr. David Eugene Smith. The average for four years (1910–14) was 54 students. In consideration of the average large class attendance (14—the range being 2 to 54) it is to be inferred that the course is primarily adapted for teachers or those preparing to teach.

In the case of chemistry the conditions differ decidedly. The total number of courses is 38, and from the general expression of opinion regarding its place in the curriculum, the history of chemistry is given solely for its intrinsic value. This value is expressed in educational terms as culture, breadth of chemical learning; it is also given with a great deal of philosophic interest by the instructors concerned. And in only one case is it offered and not given. Here again the class enrollment is high, 13 being the average attendance, and the range, from 1 to 85. This largest class in the history of chemistry for the five years, 1910–15, was composed of 85 students under Dr. Theodore W. Richards, at Harvard. The value and interest of such a course tend also to increase, judging from the answers received to the questionnaire, the larger class attendance, and the fact that a number of half-year and alternate-year courses are breaking down to a regular full-year course. These give credit for two hours each semester, which seems to be the average time for a lecture course.

There are probably only two reasons to be advanced for this state of affairs in chemistry. In the history of chemistry, beside its broad philosophic interest, the subject itself involves more of the fundamentals of other sciences, and consequently approaches the realm of the more general history of science, thereby appealing to the interest of the scientific students. Before passing, it might be well to mention a one-hour course given in the University of Pennsylvania on the history of chemistry in America, by Provost Smith. This course was instituted in 1908; it is primarily for graduates. A course in the general history of chemistry is also given; it had its beginning in 1896.

Taking up our next largest subject from the point of view of numbers, we find physics offered in 19 schools in this group. Here the study reveals a decided and strong reversal of

10 Courses in *Evolution* included.

11 Almost 15 per cent. of these are given in alternate years.

12 Five of this number are Harvard Exchange lectures.

conditions from those found in the preceding two subjects; in fact, the remaining subjects—astronomy, geology and the biological sciences, though not so large in numbers of schools represented, and class attendance—do not show indifference to the teaching, value and purpose of the course—that is, in the majority of cases. In the teaching of the history of physics this condition is marked; and for such a subject, known to be one of the fundamental sciences, this attitude is not to be expected; the study should approach chemistry in its higher educational value.

As it is, 19 courses are offered in this group of 113 schools; of these, six courses have been dropped, or are to be discontinued, and in addition, in two cases they are represented in the catalogue, but not given. The average class attendance is small (7; the range being 1–12), being half of the first two subjects mentioned.

The next study of special interest is astronomy. Here we have a subject involving other features not included in the first three fundamental sciences. In considering the small total number of schools offering astronomy (15) we must bear in mind that this is a highly technical and specialized subject, requiring expensive instrumental equipment, and that it is therefore not to be found in many curricula. If at all, it is usually represented only by a single course—a general descriptive course, and going beyond the observatory visits only in the larger schools.

This number (15) is reduced to 13, for in two schools it was discovered that instead of a history of astronomy, the history of nautical astronomy and the history of geodesy were given. The average class was found to be 9 students, with a range from 2 to 43. The relation this large class attendance of 43 (five years' average) has to the prominence of the department (University of California astronomical department, with Lick Observatory) is probably well explained by the cases already cited (mathematics in Columbia and chemistry in Harvard). As to the strength of the cultural value astronomy and its history has, all scholars agree.

Combining the study of botany and zoology with biology, we have here again a very interesting situation. The actual number of history courses in these subjects is small in comparison with the other courses, but in the number of students they are fair. Over 75 per cent. of these courses are represented by a course in evolution, history and theory. The reason for this inclusion is probably one personal to the writer; but, from his experience, it is a just reason. At two different times he has taken a course upon the theory of evolution from the biological and philosophical departments, and in each case the historical method was strongly emphasized. Probably in all the history of thought no greater principle has been discovered and developed than the doctrine and theory of evolution. One can not study evolution unless the principal factors of biology are considered, and these have a historical antecedence or sequence; and *vice versa*, one can not study biology unless he constantly bears in mind the evolutionary principles involved.

In the matter of the interest and theories of those teaching, there is a firm desire to advance this subject. From the small percentage of returned answers the figures do not represent actual conditions, but as a whole no doubt, they are fairly good. At Northwestern University a course is being given which, according to the title[18] and other information regarding methods of conducting the course, bears evidence of decided value. The class (1913–14) had a total of 13 students, with a good percentage of graduates. According to another letter, from Whitman College (Walla Walla, Wash.), Professor H. S. Brode offers a series of well-selected and comprehensive lectures on the history of biology, in conjunction with the general course—the attendance in class being on the average, 30. The reason for mentioning these special courses is to show recognition of their value, and the spirit of interest found alike in different types of schools—large and small. In Yale University in the department of zoology, we find again a valuable

18 "Source of Biological Ideas, from the Revival of Learning to the Present," by Dr. W. A. Locy.

course on the history of biology given by Dr. L. L. Woodruff as a graduate course. From 1908 to 1915 it has been offered five times, with an average of 6 graduate students, out of a department list of approximately 12 graduate students. Advanced students in biology from the college are admitted by the consent of the instructor. Bryn Mawr College offers an interesting course entitled historical biology. It is partly lecture and laboratory work, including a critical analysis of the theory of evolution.

The courses in evolution by itself, its history, theory and relation to other fields of thought through the historical development, will not be discussed here. Their importance to this field of the history of thought has a larger bearing than is at first inferred, and therefore these courses were included in this study as possessing merit.

The study of the history of botany is offered in four schools—University of Chicago (a 5-hours' quarterly course). Johns Hopkins University (3 hours), Mt. Holyoke (3), and Smith College (2). In the University of Chicago, the course is given as a seminar by Dr. John Coulter. He sounds the keynote of all historical courses, in desiring to give the students a historical background in their field of study. Johns Hopkins has a course of a type distinct from others in that it takes up special topics and discusses their historical sequence. At Smith College Dr. W. F. Ganong has offered a course for five years, which was not actually given because not enough students elected it. However, he is convinced that the historical basis of science is very desirable, and in view of such, he writes that one of his teachers was assigned to study the history of botany as a specialty, and at the same time was to collect the botanical classics.

Concerning the remaining two topics—geology and psychology—nothing of any great value was found, except in the case of geology. Two courses were offered and not given—not from lack of teaching interest, but from lack of students. University of Chicago's plan is a seminar. At Princeton University, though no formal lectures are offered, the graduate student is required to read before graduation a selected number of books, of which two are historical.[14] In the University of Michigan, the course is a small seminar for advanced students, given only once (to 3 students), but offered again this coming year—1915-16. Professor W. H. Hobbs writes, however, in a very optimistic tone; he says that the subject is susceptible of presentation to large classes along broad lines, with great profit.

Some geologists believe that the historical phase of their subject is better taken up as outside, independent reading—that teaching of the technic is of greater value (as regards the instructor's time) than lecturing upon history. The author is inclined to differ from this opinion. The average student would rather listen to lectures and spend the spare outside time upon the non-essentials of life.

In this investigation, psychology was included too late to send out questionnaires and make such further study as was necessary. The history of psychology is comparatively a new study; in fact, the subject itself has only recently been established as a science. Heretofore its destiny has been controlled by the philosophy department, and to a great extent it is even yet. But the importance of the subject is gradually attaining the dignity of an independent science, in the same degree as mathematics, physics, etc. Therefore, although the research in the records of this subject is not as wide as in some of the others, a brief survey of a few courses will be given.

Six schools of group I., and one school of group II., offer this subject with its historical significance—Harvard, Chicago, Clark, Mt. Holyoke, Illinois and Michigan. The course offered at Harvard is practically an advanced one, and open only to students who have taken four other courses in the department. It lays special emphasis on those portions of the history which are of great importance to the understanding of psychology's concepts and problems. Chicago apparently places great stress upon this subject; in the annual catalogue for 1913-14 are listed three separate

[14] Geikie, "Founders of Geology," Merrill, "History of American Geology."

courses—the "History of British Psychology," the "History of German Psychology," and "American and French Psychologists" (for graduate students). Michigan has a course entitled the "History of Modern Psychology," primarily for graduates.

In summing up the results of this study in the specific historical courses (as given in group I. *a*, Table I.) and comparing them with the study of the general historical courses, and also with the study of the other two groups (I. *b* and I. *c*) the figures themselves seem to be arguments that establish the validity and the greater merits of the general history of science course for all groups of schools. This statement is made, notwithstanding the fact that the percentage of successfully conducted courses in the specific group is probably large.

We have in the total number of courses offered in group I. *a*, 162 courses (not including seven unrelated courses previously noted). Of this number, 100 are half-year courses, and 62 full-year courses, with a total of 355 hours of instruction, thus giving an average of 2.3 hours per course, with 8.0 students as average class enrollment. Also we find, of the 162 courses and 113 schools, an average of 1.4 courses per school.

Considering now, briefly, what the figures are concerning the history of science in general, we have some telling facts. The comparison may not seem to be exactly fair, because the more general subjects are only found in the larger institutions (not including the Harvard Exchange lectures), as against the large number of smaller schools offering special courses. However, for a general study of the trend of the movement, we must look to the larger schools, and therefore this comparison may answer our purpose. In this group there are 14 general history courses, and from these 5 constitute the Harvard Exchange lectureship, which, according to the terms of exchange, is only temporary; the subject-matter changes with professor and department. The course at Throop College of Technology (a third group school) was discontinued or crowded out. Reed College presents a different type of historical course, which is not to be considered a complete course, the historical treatment being combined with a general science course. Lehigh University has a course which is a combination of the biographies and the progress of science—1 hour, 1 semester. Pennsylvania's course is given by the philosophy department, and is known as "The Philosophy of Nature." Chicago and Columbia both offer courses for the quarterly and half-year terms, in the history of the physical sciences; at Chicago Dr. Mann attempts to consider something of the history of science in America. The remaining four larger schools—Harvard, Princeton, Carnegie Institute of Technology and Massachusetts Institute of Technology offer complete courses in the history of the physical and biological sciences. In the last few years the Carnegie Institute of Technology has manifested a great activity in the general aspect of this study. Last year a course on the philosophy of science was offered, and a new, more general course upon the history of science is being planned.

The number of the smaller schools interested is encouraging, and indicates progress: Hamline University, Hunter College, Simmons College, Massachusetts Agricultural College and University of Cincinnati.

TABLE II

	General Courses (Groups I *a*, I *b*, I *c*)	Specific Courses (Group I *a*)
Total numbers of courses	20	162
Total numbers of hours	42	355
Av. numbers of hours per course	2.2	2.3
Av. nos. of students per course	39	8.0
Av. nos. of courses per school	1.0	1.4

On further analysis of the subjects, represented in group I. *a*, *b*, *c*, it can be shown (by dividing these courses into physical and biological groups—exclusive of mathematics) that the average number of hours for instruction throughout the year of each, is 2.2 hours and 2.4 hours. The average number of students for the physical group is larger than the biological group. Comparing the figures of the two divisions given in Table II., we find the

relative proportion is about the same as far as the number of hours per course is concerned; but the attendance per class in the general history of science figures is decidedly in the advance. The "specific" class enrollment of 8 students shows that the course is limited, that it is for those *prepared* to take it; whereas the "general" class enrollment is 39 students. This is, of course, the average of 8 schools; it was not possible to get figures for the balance, and therefore it would be unfair to assume that this was the average for 20 schools. It is probable, however, that this average could not alter very greatly were the entire list of figures to be had. It shows, too, that the value of the subject appeals to a large number of students, providing the question arises, "Does the size of the class indicate the general approval of such a course?"

Taking also the average hours per course from the first 8—or the largest schools—we have 3 hours, which is approximately the proper number of hours for a course of this type. Of course, all of these courses represented are not full history of science courses, as later discussion will show; but they approach the type of course advocated, namely the Harvard plan. And as far as it is possible to show by this study, the Harvard type fulfils the ideal requirements, both in treatment, number of hours for lectures, size of class, and requirements. With an advanced course in the nature of a seminar, the study would be practically complete, for those who wished to follow the subject further.

Having mentioned the subject of continuity of courses, the following table, containing schools, courses and hours of lectures, is given for further discussion.

In Table III. are listed those schools having three or more subjects bearing upon a number of particular historical courses in science. The reason for selecting these is that it takes at least that number to constitute a well-balanced continuous course in the history of the physical sciences—those three to be, preferably, mathematics, physics and chemistry. The grouping given in the table is composed of all possible arrangements of subject-matter, including the biological sciences.

TABLE III

(*Group Studies, Good Substitutes for a General Course: Mathematics, Physics, Biology—Zoology and Botany—Included.*)

Schools	No. of Courses	Subjects	Total Hrs.	Av. Hrs. per Course.
Allegheny....	4	Astr. Phys. Chem. Biol.	6	1.5
Bryn Mawr...	3	Math. Phys. Biol.	5	1.6
Columbia.....	3	Math. Astr. Chem.	7	2.3
Indiana......	4	Math. Phys. Biol. Bot.	13	3.1
Iowa State ...	3	Math. Phys. Chem.	6	2.0
Mt. Holyoke .	5	Math. Astr. Phys. Chem. Bot.	11	2.2
Univ. of Calif.	4	Math. Astr. Phys. Chem.	9	2.2
Illinois.......	3	Math. Phys. Chem.	5	1.6
Michigan.....	4	Math. Astr. Chem. Geology (4)	10	2.5
Pennsylvania .	4	Math. Astr. Phys. Chem.	8	2.0
Pittsburgh....	3	Math. Chem. Astr.	7	2.3
Wisconsin....	3	Math. Chem. Zool.	5	1.6
		Average......	...	2.7

Assuming that continuity and system were established in these courses, we should have no further argument as to their worth. But as a matter of fact, as far as it was possible to ascertain, no such condition existed in any case.

The class attendance in every case was not obtained, so that this phase of the problem is omitted. However, from the point of view of hours of instruction, the average was found to be little more than two hours (2.7). In all cases we are referring to the regular periods of instruction, namely, weekly recitations, etc. It is evident that the figure given does not satisfy the average requirement for standard (3 hours a week, general course) and can not in this sense be substituted as equal.

Probably better results would have been obtained had the investigation gone further into the question regarding the percentage of students in the scientific department of each school who took the historical course, and those who did not take the course. It was planned to work this problem along such lines,

but it was found that too many questions in the circular letter would be discouraging to those asked to fill them out, especially at a time shortly before the commencement period.

Having considered the study only in one group of schools, let us for a moment give a brief summary of the subject and its status in other groups (I. *b* and I. *c*) and compare with the first (I. *a*). Though no great results are to be expected in this comparison, sufficient interest is there to warrant setting off this table into three parts.

In regard to the total number of specific courses, we have this proportion: 27 per cent. of the courses are in the history of mathematics; 22 per cent. in the history of chemistry; approximately 9 per cent. in the history of physics; 5 per cent. in that of astronomy; 2 per cent. in history of geology; 7 per cent. in history of biology; 6 per cent. in history of zoology, and 2 per cent. in history of botany; 20 per cent. in the history of science, philosophy of science and psychology.

Restated, we have the figures: 65 per cent.

TABLE IV

Schools	No. Schools	Gen. Hist.	Math.	Phys.	Chem.	Astr.	Geol.	Biol.	Bot.	Zool.	Psych.	Phil. of S.	Total No. Courses	Miscel. Hist. Courses
Group I. *a*—Association	113	14	47	19	38	13	4	14	4	17	6	27	202	Hist. of geodesy Hist. of naut. astr. 3 courses hist. of forestry.
Group I. *b*—Library	189	3	42	11	26	4	3	9	2	5	1	6	112	2 courses hist. of geogr.
Group I. *c*—Technical	50	3	3	2	10	0	0	1	0	1	0	1	22	Hist. of engineering Hist. of mech. engineering Hist. of heat engineering.
Total	352	20	92	32	74	17	7	24	6	23	7	34	336	

From the best source,[15] the number of universities, colleges and technical schools in the United States is 598; of this number we have listed 352. The balance (246) came within the restrictions placed upon them. Of the 352 schools having courses in almost all of the sciences, 224 schools offer courses treating of the history of science (both general and specific subjects); 128 schools do not. In other words, approximately 63 per cent. of the schools listed have 336 courses—or, 37 per cent. of all the schools (598) have 336 courses. However, the basis of our calculation will be the schools given in Table IV.—352 schools and 336 courses.

Group I., 113 schools, has 60 per cent. of the courses.

Group II., 189 schools, has 33 per cent. of the courses.

Group III., 50 schools, has 7 per cent. of the courses.

[15] U. S. Commission Report, 1913.

of the courses in the physical sciences, and 15 per cent. in the biological group (including the history of evolution). The question is, then, is there more emphasis placed upon the physical group than on the biological? One is impressed, after studying Table III. and the notes following, and Table IV., with the idea that there seems to be a tendency in that direction.

This study can not properly close without at least indicating the general methods of presenting these courses in the classroom. There is no one method predominating, but in general the two prevailing methods show a natural and progressive tendency in academic instruction.

Whenever a text-book is published upon a special history of physics, mathematics, etc., it was noted that its topics are presented by the text-book with the aid of lectures and papers. When the subject is for advanced students, the seminar, reports, and references to

classical memoirs, etc., are resorted to. With few exceptions, all of the combined continuous courses just discussed are being carried out in this way.

At Harvard, Dr. Richard's method in "Historical Development of Chemistry" has decided merit, for its unique treatment. To quote from him:

> The course is conducted by a series of lectures, in which the main topics are written upon the board, somewhat after the manner of a syllabus. The students are forced to do some reading by a *system of extempore theses*, according to a plan outlined in a paper entitled "A Partial Substitute for Examination"—see *Educational Review*, November, 1908.

Attention was called in a former paper[16] to the bibliographical material in the field of the history of science. It was chiefly foreign publications, of a periodical nature. Here, attention should be directed to a special bibliography which every man, in science especially, should have in his library—namely, the "John Crerar Library List of Books in the History of Science," by A. G. S. Josephson, cataloguer (Chicago, 1911). To this a supplement is being prepared, and as a companion volume there is soon to appear a "List of Books on the History of Industry and Industrial Art." Such a volume upon the desk of any scholar in science, after he has perused its contents, can not fail to reveal to him the vast importance of his own and allied subjects—not merely as a specialist, but as a student of human affairs.

CONCLUSION

Notwithstanding the present status of the greater number of courses upon the history of science in a special field (as was shown in Table IV.), it remains to note the tendencies of progress. In so doing, this paper will conclude with a brief summary of a few replies received from men prominent in science, philosophy and education, upon the question of the intrinsic value and the future of the history course in science.

From the facts as they have been deduced in the discussion of Table I. and Table IV., there is strong evidence of the probability that the specific courses are losing favor (with the exception of chemistry and mathematics, for reasons already given, and of isolated cases in the other subjects) and that the general course is coming to be the accepted standard for history in science. The slight significance of the history of the several sciences is probably the best argument for the more general history course.

Therefore, as the figures now stand, it would seem that it is far more advantageous to offer a course of three hours throughout the year with a larger class enrollment in the general subject, than to have so many scattering courses offered with an average of two hours, and a very small class attendance. From the point of view of efficiency in educational administration, and educational values, both in the instructors' and students' interest, the general course is far more desirable.

The salient points of the value and importance of a course, such as its use for culture, general depth, breadth of scientific knowledge, and training, were all brought out on the introduction of this paper. And as far as further study of the subject is concerned, a list of short articles will be found appended as a bibliography of the subject.

It is evident from the inherent nature of the specific history course in science (such as physics, chemistry, etc.) that it has value only for a limited number of students. Whereas the course of the more general history of science, treated broadly and thoroughly, has a far greater application and merit—and affects a larger number of students. The methods of treatment in both cases vary only in the degree of application, and not essentially in subject-matter, except in the amount considered vital to a well-developed course. For example, take the history of chemistry. In such a course the instructor can with proper allowance (for the confines of all specific courses are restricted more or less) dwell upon the history of chemical theories in a far larger sense than it is possible or practical to do in the more general history of science course. He can also en-

[16] See SCIENCE, N. S., Vol. XLI., pp. 358–360 (1915).

large upon the technic of its methods, give a more minute examination to the development of chemical concepts (historically), and finally, move with greater intimacy in the study of the lives of eminent chemists.

On the other hand, in the study of the history of science as a whole, we come to the chronological order, and principles, as well as the relationship and parallel progress of all sciences, their order of logical sequence, and application of science to the progress of civilization, and a conception of what the world owes to science. Also it allows a wider selection and interest in the vital part of all historical study—the biographical study. Lastly, in seeking for a greater analysis of the problems of the future in science, the history of science furnishes the background for all future investigations and progress.

The question is not, do we need more courses in our over-developed curricula, but a larger degree of intensive and correlated courses in order to bring out the better human faculties for greater service and deeper insight into the problems of nature. The failure of universities, colleges or technical schools, to make the necessary provisions for courses in either specific or general history of science, decreases their general efficiency, especially in their scientific curricula. From the point of view of economy in academic administration, and taking into consideration the merits of each case, as they have been set forth, the choice should certainly be with a general history of science course.

As Professor A. O. Lovejoy, of Johns Hopkins, writes:

> One hesitates to suggest further increase in the already too-diversified supply of mental pabulum urged upon undergraduates; but I should think an introductory course in the history of science would be a valuable addition to the curriculum of any college.

Further, he says that the history of science is assuredly important enough to be recognized as a distinct branch of teaching and of research. Professor Josiah Royce writes also; he points out how

> a deadening influence of a too exclusive absorption in the technique of one's own specialty could be prevented by the study of the history of science. Such a study is at once humanizing and an important auxiliary training towards acquiring a good method in technical work.

It is interesting to note that a number of years back some of our prominent men in science pointed out the present trend of this study as it is brought out in this investigation. Dr. R. F. Moulton, of the University of Chicago, was of the opinion that "it is worthy of a much better place than it now (1909) has"; Dr. Henry Crew, of Northwestern University, expressed a hope that as time went on the history of science should become a separate topic of study for advanced students; Dr. Florian Cajori, of the University of Colorado, inclined to the opinion that the stronger universities of the country would pay more and more attention to the history of science as the years went on.

Having now seen what the "expert opinion" has been regarding the future interest in the history of science, especially in our more prominent universities, within the last five or six years, it may be confidently expected that in the next few years very rapid progress will be made. No doubt many conditions have prevailed which retarded this progress, and probably the strongest one is that no well-adapted text- or source-book, or selected reading, is available. This is evident, and scientific men are aware of this deficiency. At the present time, two series of volumes are being prepared to aid the methods of teaching this subject. At the Massachusetts Institute of Technology, Professor W. T. Sedgwick and Professor H. W. Tyler are preparing a two-volume text entitled "Outlines of the History of Science," designed expressly for the use of their own classes. Volume I. is to deal with the rise and progress of science and scientific spirit to the fall of the Roman empire. Volume II. treats of the development of science in medieval and modern times.

Dr. Walter Libby, of the Carnegie Institute of Technology, with the collaboration of Dr. Locy and Dr. Crew, of Northwestern University, is preparing a series of short volumes: the History of the Biological Sciences, the History

of the Physical Sciences, an Introduction to the History of Science, and a probable fourth volume on the Applications of Science.

It has often been emphasized that the history of science can not be taught because of its encyclopedic extent. This objection can be overruled. It is true that we can not all be a Leibnitz, or possess minds of the type of his; however, in our modern methods of training or in specialized education, we may at least obtain the broadest viewpoint possible—through historical methods and their perspective, and withal, historical inspiration.[17] The principles of history have a criterion based upon scientific methods, just like any other subject of study intended for philosophical interpretation. This must be recognized by the future historian of science.

And when the historian of science is fully imbued with the "Geist und Leitmotiv of human learning," then, and only then, can the history of science be of value, and be possessed of a future. The final message of the history of science is to show the high plane of science—that which has given life, stability, truth and wealth—in its universal activities and its established international character as the arbiter of the future of man and of peace.

BIBLIOGRAPHY

Mann, Dr. C. R., "The History of Science—An Interpretation," *Pop. Sci. Monthly*, Vol. 72, 1908, pp. 313 ff.

Mead, Dr. G. H., "The Teaching of Science in Colleges," SCIENCE, N. S., Vol. XXIV., 1906, pp. 390–397.

Libby, Dr. W., "The History of Science," SCIENCE, N. S., Vol. XL., 1914, pp. 670–673.

Carmichael, Professor R. D., "The Outlook of Science," SCIENCE, N. S., Vol. XL., 1914, pp. 833–840.

True, Professor A. C., "The Relation of the College Curriculum to Human Life and Work," *School and Society*, Vol. I., 1915 (June 19), No. 25.

Twiss, Professor G. R., "Present Tendencies in Science Teaching," *School and Society*, Vol. I., 1915 (March 13 and 20), Nos. 11, 12.

[17] See "Outlines of the Principles of History," by Johann G. Droysen (1897), trans. by E. B. Andrews, pp. 9–58.

Woodhull, Dr. J. F., "Science for Culture," *School Review*, Vol. XV., 1907 (February).

FREDERICK E. BRASCH

STANFORD UNIVERSITY,
CALIFORNIA

THE COMMITTEE ON POLICY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE committee met at 5 P.M., on November 15, in the room of the New York Academy of Sciences, American Museum of Natural History, New York City (continued later at the Hotel Majestic), with Messrs. Pickering, Paton, Woodward, Noyes, Fairchild, Cattell and Howard present.

The preliminary announcement and arrangements for the Columbus meeting were considered. It was recommended that public addresses be worded so as not to allude to the present war in a way which might give offense. Dr. W. W. Campbell, president of the association, was appointed as delegate and Dr. L. O. Howard, permanent secretary, as alternate to the Second Pan-American Scientific Congress. The question of the relation of the association to the congress was referred to a special committee consisting of Messrs. Woodward, Howard and Humphreys.

Mr. Pickering submitted a report of progress for the committee on expert testimony.

Mr. Woodward submitted a report on the Coburn bequest.

Other matters considered by the committee and its recommendations will be submitted to the council at the Columbus meeting of the association.

At 9.30 P.M. the committee adjourned.

L. O. HOWARD,
Secretary

SCIENTIFIC NOTES AND NEWS

As was stated in SCIENCE last week, the Nobel prize in chemistry for 1914 has been awarded to Professor Theodore William Richards, of Harvard University, and the prize in physics to Professor Max von Laue, of Frankfort-on-Main, for his work on the diffraction of rays in crystals. The prize in medicine has been awarded to Dr. Robert Barany, of

the University of Vienna, for his work on the physiology and pathology of the vestibule of the ear. According to a Reuter dispatch from Stockholm, two of the Nobel prizes for 1915 will be awarded as follows: chemistry—Dr. Richard Willstaetter, of the University of Berlin. Physics—divided between Professor William Henry Bragg, of the University of Leeds, and his son, W. L. Bragg, of Cambridge University, England, for research in the structure of crystals by use of the Röntgen rays. The prize for medicine for 1915 is reserved until next year.

NOVEMBER 24 was the seventy-fifth birthday anniversary of John Alfred Brashear, whose name has been intimately associated, for half a century, with the civic, scientific and intellectual progress of Pittsburgh. His friends celebrated his many years of unselfish and enthusiastic devotion to the public welfare, by a popular subscription dinner, at which an opportunity was afforded to express to him their appreciation of his services, and their hopes for long continuance of his useful and inspiring life. The dinner was held in the banquet hall of the Soldiers' Memorial Hall and was in charge of a committee of seventy-five.

Nature states that the committee which was constituted last year to promote testimonials to Professors Perry and Harrison on their retirement from the staff of the Imperial College (Royal College of Science) has now completed its labors. The testimonial to Professor Harrison, who has been associated with the department of mathematics and mechanics during thirty-two years, has taken the form of an illuminated address, accompanied by valuable personal gifts. In the case of Professor Perry, former students of the Finsbury Technical College desired to be associated with the testimonial, in recognition of his valuable services to that institution prior to his joining the staff of the Royal College of Science in 1896. The governing body of the Imperial College having readily consented to act as trustees, the aim of the committee was to establish a permanent memorial of Professor Perry's work in the form of a medal or prize to be awarded annually at each of the two institutions. Dies have been prepared from designs by Mr. Charles Wheeler, of the Royal College of Art. A silver medal will be awarded annually to a student of the Imperial College for distinction in mathematics and mechanics, and at the Finsbury College a similar award will be made for distinction in mathematics and engineering.

WITH addresses by Governor Frank B. Willis, Dr. Thomas C. Mendenhall, Chief C. F. Marvin, of the Weather Bureau, and Professor J. Warren Smith, the Ohio Academy of Science will hold its quarter-centennial meeting on November 26 and 27. Professor Smith, who is president of the academy, will give the annual address. Dr. Marvin's subject will be "The Work of the Weather Bureau." Dr. Mendenhall will discuss "The Relation of the Academy to the State and to the People of the State." Professor William R. Lazenby, of the department of forestry of the Ohio State University, will give a historical sketch of the academy.

DR. WALTER O. SNELLING, of Pittsburgh, has bought land in Long Island City on which he will erect laboratories for chemical research.

ALFRED W. BOSWORTH, associate chemist at the New York Agricultural Experiment Station, who has been engaged in experiment station work during the past sixteen years, has accepted the position of chief of the department of biological chemistry of the Boston Floating Hospital, beginning about the first of the new year.

HERBERT T. OSBORN, a graduate of the Ohio State University in 1909, son of Professor H. Osborn, of the department of zoology, has been sent by the Sugar Planters' Association of Honolulu to Formosa, to secure parasites to use in Hawaii to exterminate the cane beetle.

AT the Chemists' Club, New York, on November 10, there was a gathering of the following industrial chemists, at a dinner tendered by the management of the exposition, to discuss plans for the next National Exposition

of Chemical Industries: Raymond F. Bacon, Chas. H. Herty, Henry B. Faber, A. D. Little, E. F. Roeber, George D. Rosengarten, T. B. Wagner, L. H. Baekeland, M. C. Whitaker, B. C. Hesse, Adriaan Nagelvoort and Chas. F. Roth; also Mr. R. D. Hollman and Mr. F. W. Payne of the International Exposition Company were present, all of whom will serve on the advisory committee for the 1916 National Exposition of Chemical Industries to be held at the Grand Central Palace, New York City, during the week of September 25, 1916. Dr. Chas. H. Herty was elected to serve as chairman of the committee for the coming year. Plans for enlarging and increasing the scope of the exposition were laid, which will assure a very large exposition both from the attendance standpoint as well as exhibits. The plans include using several floors of the Grand Central Palace, with speakers in the evening and motion pictures during the day from 11 A.M. to 7 P.M.

The anniversary meeting of the New York Academy of Medicine, held on November 18, was devoted to the subject "Disease and Crime—an Analogy." The speakers were George W. Wickersham, president of the Bar Association of New York, "The Concern of Society in the Problem of Crime"; Thomas Mott Osborne, warden of Sing Sing prison, "The Part which Penal Institutions Might be Made to Play in the Solution of the Problem," and Judge Harry Olson, chief justice of the Municipal Court of Chicago, "The Progress that has been Made and What the Future Promises."

Dr. Henry Charlton Bastian, the distinguished London neurologist, the author also of books on the origin of life, died on November 17, at the age of eighty years.

Raphael Meldola, professor of organic chemistry in the University of London, died on November 16, at the age of sixty-six years.

Dr. Philippe Hatt, the French astronomer and hydrographic engineer, has died at the age of seventy-five years.

Dr. F. Hasenöhrl, professor of physics at Vienna, has been killed in the war. He succeeded Boltzmann, whose pupil he was and whose works he edited, in the chair at Vienna.

The twenty-fourth meeting of the American Psychological Association will be held at the University of Chicago, on December 28, 29 and 30. The annual dinner-smoker, with the address of the president, Professor John B. Watson, will occur at the Quadrangle Club on the evening of December 29.

The fifteenth annual meeting of the American Philosophical Association will be held at Philadelphia, Pa., on December 28, 29 and 30, in acceptance of the invitation of the philosophical department of the University of Pennsylvania. The session will begin on Tuesday afternoon. The meeting will have some special features, which will be announced when arrangements are completed. The association meets alone this year, and there will be no joint discussion, and no special topic as at recent meetings.

According to the *Weekly Bulletin* of the New York City Department of Health in a service of less than two years as commissioner of health of the city of New York, Dr. S. S. Goldwater effected the following reforms:

1. Placing most of the important supervisory positions on a full-time basis, with a corresponding increase in the salaries attaching to the positions.

2. Establishing a bureau of public health education under a director chosen as the result of an open competitive examination, and insisting on education as an indispensable factor in public health administration.

3. Establishing a division of industrial hygiene, thereby properly claiming as a health department function an important but hitherto neglected field of public health activity.

4. Establishing a division of statistical research by readjustment of existing positions within the bureau of records.

5. Revision of the sanitary code and formulation of a complete set of regulations thereunder.

6. Advancing the work of school medical inspection by providing that private physicians may make the required physical examinations.

7. Broadening the application of the dog muzzling ordinance and thereby reducing the prevalence of dog bites and the number of rabid animals in this city.

8. Waging a persistent campaign against fraudulent patent medicines and securing the adoption of an ordinance providing that the names of the ingredients be printed on the label of all nostrums sold in this city.

9. Providing for the regular annual physical examination of all employees of the department of health.

10. Reorganizing the bureau of food and drugs and placing at its head a recognized authority in this field, chosen as the result of an open competitive examination.

11. Inaugurating a campaign of education against the use of alcohol as a beverage.

12. Insisting on the recognition, as a menace to health, of overcrowding in the street cars, and compelling the street railway companies to provide the service needed to the limit of their capacity.

THE program for the year of the Society of the Sigma Xi, of Northwestern University, is as follows:

October 28. "Chemical Control of Body Functions": Professor R. G. Hoskins.

November 17. "Scientific Problems of Flight and the best Possible Ways of Attacking Them": Director John F. Hayford.

December 9. "Galileo": Professor Henry Crew.

January 12. "Bill's School and Mine": Professor W. S. Franklin. Initiation of new members.

February 17. "Five Outstanding Events of Biological Progress": Professor W. A. Locy.

March 9. "Conduction of Pain and Temperature": Professor S. W. Ransom.

April 13. "Microbic Warfare in the Intestinal Tract": Professor A. I. Kendall. Dinner and annual meeting; election of new members.

May 18. Last meeting of year, to be addressed by a speaker from another university. Initiation of new members.

UNDER the auspices of the Rush Society and other medical organizations of Philadelphia lectures on medical and allied subjects have been arranged as follows:

The Samuel D. Gross Lecture of the Pathological Society of Philadelphia, October 14, by Dr. Eugene L. Fiske: "The Increasing Mortality from Diseases of the Heart, Blood Vessels and Kidneys."

The Twelfth Rush Society Lecture, November 29, Professor Daniel J. McCarthy, University of Pennsylvania Medical School: "Medical and Social Problems Incident to War."

The Mütter Lecture, December 17, Professor Rudolf Matas, Tulane College of Medicine: "The Fundamental Principles that Underlie the Surgical Treatment of Aneurysm."

The Thirteenth Rush Society Lecture, January 21, Dr. F. M. Allen, Rockefeller Institute of Medical Research: "Investigative and Scientific Phases of the Diabetic Question with Their Probable Relations to Practical Problems of Clinical Medicine."

The Frederick A. Packard Lecture of the Philadelphia Pediatric Society, February 8, Professor Charles M. Campbell, Johns Hopkins Medical School: "The Neurotic Child; Some Familiar Symptoms and Their Problems."

The Fourteenth Rush Society Lecture, March 7, Professor Richard P. Strong, Harvard Medical School: "An Investigation of Typhus Fever in Serbia." (This lecture is also the annual address before the Alpha Omega Alpha Honorary Medical Society.)

The Fifteenth Rush Society Lecture, April 6, Professor John M. T. Finney, Johns Hopkins University: "What Constitutes a Surgeon." (This lecture is also the annual address before the Undergraduate Medical Society of the University of Pennsylvania.)

Annual Address of the Pathological Society of Philadelphia, April 27, Professor William H. Park, University and Bellevue Hospital Medical College. (Title to be announced later.)

UNIVERSITY AND EDUCATIONAL NEWS

APPROXIMATELY $1,000,000 is to go to Yale University under the will of Justus S. Hotchkiss, of New Haven. The trust fund thus established is to be shared equally among the academic, law and theological departments.

THE plans for the merger of the Medico-Chirurgical College and the Medical School of the University of Pennsylvania were agreed upon finally on November 15, following a conference of representatives of the two institutions. The Polyclinic Hospital of Philadelphia, which maintains a post-graduate medical course for physicians, may also merge with the University of Pennsylvania.

IN Washington University (St. Louis), as announced in SCIENCE last week, Dr. Leo

Loeb has been appointed to a newly established chair of comparative pathology in the medical school. The creation of this special research department is made possible by a fund provided for five years by friends of the university for the purpose. The university announces also the appointment of Philip A. Shaffer, Ph.D., as dean, June 3, 1915, and the following promotions: Borden S. Veeder, M.D., to associate professor of pediatrics; Robert A. Gesell, M.D., to associate in physiology; Philip C. Jeans, M.D., to instructor in pediatrics.

MR. W. F. TURNER, of Beltsville, Md., has been appointed to the position of extension instructor in animal husbandry at the Massachusetts Agricultural College, the position left vacant by the resignation of Mr. G. E. Story, who recently went to the University of Vermont as professor of animal husbandry.

DR. ROBERT RETZER, formerly of the University of Chicago, has accepted the professorship of anatomy and deanship of the Creighton Medical College, Omaha. Mr. A. J. Key, formerly assistant in anatomy at the Johns Hopkins Medical School, has been made instructor of anatomy. Dr. G. W. Earle, of Tufts College, has been appointed instructor in pathology and director of the clinical laboratory.

DR. LEONARD ROWNTREE, associate professor of medicine in the Johns Hopkins Medical School, has accepted the position of professor and chief of the department of medicine in the University of Minnesota.

THE changes in the faculty of the engineering departments of Brown University for the year 1915–16 are as follows: Professor P. B. Perkins, who was assistant professor of mechanics last year, has been appointed assistant professor of applied physics and teaches some of the courses in physics and electrical engineering. Mr. James A. Hall, who was on leave of absence last year and spent the year in the engineering department of the Link Belt Company, Philadelphia, has returned to take up the position of assistant professor of mechanical engineering, having charge of the courses in machine design. Mr. Frank C. Blake has been promoted from assistant in mechanical engineering to instructor. Mr. Thomas C. Shedd, who was instructor in mechanical engineering last year, has withdrawn from the university to accept a position with the Phœnix Bridge Company. Mr. Robert F. Field, who was instructor in electrical engineering for a period of five years, has resigned to take up graduate work in physics at Harvard University.

DISCUSSION AND CORRESPONDENCE

ARTIFICIAL DAYLIGHT

TO THE EDITOR OF SCIENCE: In the issue of SCIENCE for October 15, 1915, Professor Simon H. Gage discusses a color filter, recently devised by Dr. H. P. Gage which produces an artificial daylight when used with the nitrogen-filled tungsten lamp. Under the caption "Artificial Daylight for the Microscope" Professor Gage not only commends highly the use of artificial daylight in microscopy but also refers to its great potential value in the textile and dye industries, in chemistry and in medicine. Inasmuch as Professor Gage apparently is not cognizant of the fact that artificial daylight was scientifically achieved several years before the work of Dr. H. P. Gage, that attention was called several years ago to its possible use in microscopy, and for the past several years various daylight units have been on the market, that at present several thousand daylight units of the types developed by the writer are in daily use, it seemed advisable to give the readers of SCIENCE a brief résumé of the subject.

In 1900 Dufton and Gardner[1] described a colored glass for accomplishing the desired result and since that time many have worked on the problem. In 1911 Ives and Luckiesh[2] described a color filter which produced a sufficiently accurate artificial daylight and described the entire procedure. Quite a number of these units were installed in various fields

[1] British Assn. Report, p. 631, 1900; *Jour. Soc. Chem. Ind.*, Vol. 23, p. 598, 1904.

[2] *Elec. World*, May 4, 1911; *London Illum. Engr.*, Vol. 4, p. 394, 1911.

but, owing to the fact that a dyed gelatine was necessary to obtain a final correction, this unit was limited in application. Since that time both Ives and Brady, and the writer independently produced such filters in a single glass.[3] Mr. R. B. Hussey[4] developed a filter in 1912 for use with the intensified arc. Mees, Pirani, Weertz, and others have also worked on the problem.

The units developed by the writer have been designed for solving various problems and include accurate color-matching units for the most exacting color-work as well as more efficient yet sufficiently accurate units for the rougher color-work. Several thousand of these units consisting of a single colored glass are in daily use and have not only passed the spectrophotometric tests, but the tests of many different practical applications. The writer[5] emphasized the application of these units in microscopy and besides being applied to this field, many units are in daily use in color-matching, lithography, cigar sorting, medical diagnosis, horticulture, oil refining, surgery, color photography, hair dressing, art exhibits, painting, paint factories, chemical laboratories, laundries, in millinery, dry goods, clothing and jewelry stores, textile mills, art schools, paper mills, and many other places.

M. Luckiesh

Nela Research Laboratory,
National Lamp Works of G. E. Co.,
Nela Park, Cleveland, Ohio

INJECTIONS OF THE BUNDLE OF HIS

To the Editor of Science: In a letter published in Science of November 12, 1915, Dr. A. W. Meyer, of Stanford University, complains that injustice has been done to his former associate, Dr. Lhamon, who devised a method of injecting the bundle of His, by the publication of a note by Dr. Cohn describing hearts injected by this method, before the appearance of Dr. Lhamon's paper.

The circumstances were as follows: Dr. Meyer showed me the injections when I was in his laboratory in California and, on my return, as the preparations had interested me very much, I spoke of them to a number of men including Dr. Cohn. I made it clear at that time that the method had been devised by one of Dr. Meyer's assistants and every one who heard of it was aware of this. Dr. Cohn was not then my assistant, but was working at the Rockefeller Hospital, where he experimented with the method in connection with his own work.

Dr. Meyer's letter is so worded that it might give the impression that I, after an apparently friendly visit, betrayed his confidence by having an assistant anticipate his publication of the new method. This is unfortunate, for I can not believe that he intended to imply such a thing.

The publication was not made by one of my assistants, nor at my suggestion, nor even with my previous knowledge of its nature. Furthermore I was not present at the meeting of the New York Pathological Society when the injected hearts were demonstrated, else I should have emphasized the fact in the discussion that this was a method devised in Dr. Meyer's laboratory. Nevertheless it appears in the published discussion that the method had first been heard of through me.

I am impelled to write this in defense of Dr. Cohn, because I feel convinced that he had no intention of claiming priority. Every one connected with the matter regrets exceedingly the inopportune publication of the first note and the carelessness which let it pass into print without definite mention of Dr. Lhamon's work.

W. G. MacCallum

College of Physicians and Surgeons,
Columbia University,
November 18, 1915

To the Editor of Science: In Science of November 12, 1915, appears a letter from Professor A. W. Meyer, of Stanford University, in which, in behalf of his former associate, Dr. Lhamon, he very vigorously asserts a claim for priority in injection of the conduction system in mammalian hearts. If the sole purpose of

[3] *Trans. I. E. S.*, Vol. 9, p. 840, p. 937, 1914; *Elec. World*, Sept. 17, 1914; *Jour. of Franklin Inst.*, Vol. 177, p. 471, 1914; *Elec. World*, Apr. 4, 1914.

[4] *Trans. I. E. S.*, Vol. 7, p. 13, 1912.

[5] *Elec. World*, July 10, 1915.

this letter were to clear up any misunderstanding as to priority on behalf of Dr. Lhamon, no reply would be required, but since the letter is so written as to suggest that an attempt has been made by my associate, Dr. Alfred Cohn, to unjustly obtain credit for this discovery, it seems that a reply is demanded, especially since Dr. Meyer has apparently drawn conclusions concerning Dr. Cohn's motives which are quite out of harmony with what his friends know of his character.

I am quite familiar with the work that Dr. Cohn has done on this subject, and have now carefully reviewed the publications in question, and also have seen the correspondence which has passed between Dr. Cohn and Dr. Meyer. In the light of all that I can learn in regard to the matter, it would seem that so far as the actual matter of priority is concerned Dr. Meyer is needlessly alarmed, and it is very unlikely that in future generations any one is going to claim that Dr. Cohn was the first to prepare such injections. Dr. Cohn himself, in a letter to Dr. Meyer which Dr. Meyer quotes, has stated that "so far as priority is concerned, not only I, but every one acquainted with the subject, gives and has given full credit to Lhamon."

The chief purpose of Dr. Meyer's letter, therefore, seems to be to take Dr. Cohn to task for having presented before the New York Pathological Society in December, 1911, ox hearts showing injection of the conducting system. These hearts were prepared by Dr. Cohn for purposes of demonstration in the Hospital of the Rockefeller Institute, in order to make more clear the discussion of lesions of the conducting system. The idea of carrying out such injections came from a conversation with Dr. MacCallum, in which the latter stated incidentally that he had seen hearts at Stanford University with conduction system injected. Dr. Cohn at this time was no longer a member of Dr. MacCallum's staff, having been appointed associate in medicine in the Hospital of the Rockefeller Institute. Dr. MacCallum told Dr. Cohn nothing of the details of the method, nor did Dr. Cohn have any communication with Dr. Oppenheimer on the subject, but he experimented quite independently, and, after trying various dyes, finally succeeded in preparing some beautiful specimens, using India ink for the purpose. In his demonstration of these specimens before the staff of the hospital at our weekly meeting, Dr. Cohn made no claim, and made no attempt to lead the staff to infer, that he was the first to discover that such injections might be made, or that he was the discoverer of a method of making such injections. Indeed, all the members of the staff, including myself, fully understood otherwise. Dr. Cohn did not state who had first made such injections, however. Indeed, as he tells me, at that time he did not know the name of the person who had done so.

The injected hearts were so beautiful and instructive that at a meeting of the Pathological Society, occurring shortly after they were made, he demonstrated them to the members present. At this meeting no attempt was made to claim credit for the method. Indeed such a claim would have been preposterous, since Dr. MacCallum, the president of the society, had himself told Dr. Cohn of seeing such injections in California. So far as can be learned, no one at the meeting of the Pathological Society was deceived by Dr. Cohn, and no attempt was made to deceive. The Proceedings of the Pathological Society which are published consist mainly of brief notes, in the form of abstracts of the remarks of those making demonstrations or reports. In the volume for 1911 appears such a report, one page in length, concerning Dr. Cohn's demonstration. Previous to the meeting Dr. Cohn had made no notes, and his demonstration was entirely informal. This demonstration by Dr. Cohn was in no way considered as a publication. No effort had been made to find any literature concerning this subject, and the demonstration was not given with any idea of establishing priority, or indeed of obtaining any credit for discovery of a new method. It is quite true that Dr. Lhamon's name was not mentioned at this demonstration, and his name does not appear in the note published in the Transactions. This is indeed unfortunate and if it has led, or were likely to lead, to any misunderstanding, I am

sure that Dr. Cohn and all concerned would regret it exceedingly.

Dr. Lhamon's paper describing the method appeared in the *American Journal of Anatomy* for March, 1912, and Dr. Cohn's publication did not appear until May, 1913 (*Heart*, 1913, iv, 225). Dr. Cohn's paper dealt with the subject in a different manner from Dr. Lhamon's, and did not purport to be the description of a new method. In this paper Dr. Cohn expressly states how he learned that such injections were possible, and gives a reference to Dr. Lhamon's communication. It hardly seems, therefore, that Dr. Meyer has any serious ground for complaint or cause for worry. If any doubts remain in his mind, he should be reassured by the fact that in the monograph by Aagaard and Hall, "Ueber Injektionen des 'Reizleitungssystems' und der Lymphgefässe des Säugetierherzens" (Wiesbaden, 1914), priority is given to Lhamon, although they were familiar with Cohn's paper in which reference is made to the report in the New York Pathological Society Transactions.

Rufus Cole
Hospital of the Rockefeller Institute,
November 16, 1915

SCIENTIFIC BOOKS

Methods in Plant Histology. By Charles J. Chamberlain, professor of botany in the University of Chicago. University of Chicago Press, 1915. Price $2.25.

When a work like the present has reached its third edition there can be no question as to its value for the public to which it appeals. It begins with an account of apparatus, including some valuable improvements which have originated in the botanical laboratories of the University of Chicago. There follow chapters on reagents, stains and staining, microchemical tests, free-hand sections, the glycerin method, the Venetian turpentine method, the paraffine method, the celloidin method, special methods and photomicrographs and lantern slides. The last two chapters contain the chief novelties of the edition and one can only say of them that they are excellent but might with advantage be much fuller. One wonders, however, why slow contrast plates are used for the photomicrographs instead of more rapid iso- or chromatic plates, which would give better results in much less time.

The second part of the treatise, covering more than half its total number of pages, is devoted to the specific directions for securing and studying representatives of the various groups of lower and higher plants. This section of the work will appeal specially to those taking extension courses and to teachers, whose acquaintance with laboratory methods is not recent. Following the specific directions for the study of the larger groups of plants are final chapters on the use of the microscope, labelling and cataloguing preparations, class list of preparations and formulæ for reagents. Last of all the book closes with a good index. It is copiously illustrated often by means of excellent photomicrograms. The best that can be said of this work is that it will do for the American student of botany, what Strasburger's "Botanische Practicum" has done for those of all lands. Like the "Practicum" of the great German morphologist it has passed through a number of editions, an unquestionable tribute to its value.

E. C. Jeffrey

W. I. Palladin, Pflanzenanatomie, nach der fuenften russischen Auflage uebersetzt and bearbeitet. Von S. Tschulok. Leipzig u. Berlin, B. G. Teubner, 1914.

This work on anatomy by one of the professors of botany in the University of St. Petersburg (Petrograd) is essentially the so-called physiological plant-anatomy of Haberlandt, tempered with a large infusion of the morphology of Strasburger. It is a curious phenomenon to find German ideas thrown into the form of a book and illustrated with figures of German origin by a Russian botanist, translated back into the Teutonic speech for German consumption. The loss in this peculiar sort of metempsychosis is much less than one would suspect but the advantage of it is difficult to imagine. The work in question is chiefly valuable, not because it presents any new points of view or is illustrated by any new figures, but because it presents a clear and readable résumé

of the subject from the point of view of physiological plant anatomy. That point of view is for the present, however, somewhat under a cloud in this country because it does not appeal to the morphologist and the evolutionist on the one hand or to the cultivator of the disembodied plant physiology at present in vogue in these United States, on the other. When the physiologist among us again begins to recognize the importance of plant structures, he will possibly find a work conceived in this manner useful.

E. C. Jeffrey

America's Greatest Problem: the Negro. By R. W. Shufeldt, M.D., major, medical corps, United States Army, member Association of American Anatomists, fellow of the American Ornithologists' Union, etc. Philadelphia, 1915. Roy. 8vo, pp. 377, with fifty-two illustrations.

Unfortunately this volume has been heralded as "a wonderfully startling book . . . certain to instantly arouse a vigorous nation-wide discussion," and—by implication—as "an authoritative . . . guide to the solution of this menace of the deterioration of the Caucasian race in America." Nevertheless (these hyperboles being credited to the mercantile enthusiasm of the publishers, whose part has been done quickly and well), a notice of it was undertaken by the present writer partly because of his interest in the Negro, and partly because he took for granted that the author, a well-known ornithologist and comparative anatomist, would materially increase our knowledge of the facts involved, facilitate our comprehension of the nature and causes of the existing undesirable relations between the races, and offer something novel as "a remedy whereby the peril may be safely passed."

These expectatons have not been met. On the contrary, while the author's earnestness is evident, a careful and unprejudiced examination of the volume leads the reviewer to wish that the time and energy expended upon it had been devoted to the strictly scientific work which the author had in hand (p. vii); that might, at least, have been free from the needlessly frequent references to topics connected with *psychopathia sexualis* which characterize this and some of his other publications.

Burt G. Wilder

SPECIAL ARTICLES

ZYGOSPORES AND RHIZOPUS FOR CLASS USE

Rhizopus nigricans—the common bread mold—is the form most frequently used in the microscopic study of fungi in elementary classes in botany. Its production of both sexual and non-sexual spores, added to the ease with which it may be obtained and grown without refined laboratory facilities, makes it an ideal form for class study. The zygospores, though not difficult to find, have been overlooked by most teachers and many requests have been made of the writer for information in regard to methods of obtaining them. It has seemed desirable therefore to publish a short note on the subject.

Rhizopus is commonly found in nature on decaying fruits and vegetables as well as upon bread which has been kept in a moist atmosphere. The air is so full of its spores that almost any substratum rich in carbohydrates, if kept under proper moisture conditions, will produce a spontaneous growth of the fungus. The essential precaution is to insure a moist atmosphere and at the same time to prevent the substratum itself from becoming so moist as to stimulate the growth of bacteria. A simple method is to line a tumbler with moistened filter paper or even newspaper and to place a piece of bread on some non-absorptive object inside that will keep it from contact with the moist paper on the sides and bottom. The bread should be moist but not wet—the consistency of fresh bread is ideal—and the container should be kept closed. A bell jar lined with moist filter paper covering a dish with water or moist paper on the bottom, also makes a good moist chamber. Within a week, if the air has been kept moist, a good growth of the mold will result. Green molds will often be present as well, but the *Rhizopus* is so rapid in growth that contamination with other forms will not generally be seriously troublesome. Zygospores will sometimes be

found in the lower and moister parts of the culture below the sporangial growth but need never be expected in the upper and dryer regions. They frequently form in pure masses free from sporangia in the folds of crumpled paper directly below the substratum. The species, however, is diecious and it may frequently happen that the spores of only one of the two sexes, which together are necessary for zygospore production, have fallen upon the substratum. The chances of finding zygospores in the lower parts of a spontaneous culture will be increased if bits of the fungus from different sources in the field are laid on the bread when the culture is started. The two sexes are often found growing together in nature although the moisture conditions may not be such as to cause the appearance of zygospores. Thus, out of seven mixed transfers made this last month from as many individual decayed squashes in the field, three showed the presence of the two sexual races by production of zygospores, and of the remainder one was male and three were female. If even a small mass of zygospores is found, their production can be increased by laying on a fresh culture of bread, a bit of such zygosporic material freed as much as possible from sporangial spores. When an abundant production of zygospores has been once secured, the bread with the fungus growing on it can be dried and kept six months or more to be used later as "spawn" if broken up and laid on fresh bread when a zygosporic culture is again desired. Cultures have been kept over a year in this way but the spores are relatively short lived and fresh "spawn" should be prepared at more frequent intervals.

Zygospores of *Sporodinia* also may be readily obtained from sowings of the spores on bread in moist chambers. This mold is hermaphroditic. If a large collection of different fleshy fungi are left for a few days under a bell jar, a sporangial growth of *Sporodinia* will usually be found appearing on some of the decaying fungi.

In studying the habit of growth of the bread mold, pieces of paper on which the mold has spread will be found convenient or masses of the mold-infected bread (about half the size of an English walnut) which is beginning to show sporangia may be left for 24 to 48 hours in Petri dishes. If the Petri dishes are kept in too moist an atmosphere, stolons with but scanty sporongia may result, if kept too dry no stolons will be produced. If the Petri dishes be wrapped in paper, the proper conditions are generally secured. The presence of the columella within the unopened sporangium may be shown by drawing a solution of KOH under the cover.

To observe the swelling and germination of the sporangial spores, they may be sown in suitable fluid media or on nutrient agar. The filtrate obtained after boiling a couple of prunes for five or ten minutes in 100 c.c. of water makes a convenient fluid for the purpose without the necessity of further sterilization. Only enough spores should be added to make the fluid slightly clouded or to give a sufficient number of germinations in a drop taken for observation. At room temperature the formation of germ tubes may be expected in five or six hours. The process may be hastened or delayed by keeping the spores at higher or lower temperatures.

The methods suggested in the preceding paragraphs have been purposely such as can be adopted by any teacher without the facilities for sterilization. It will not be necessary to give detailed directions to those familiar with cultural methods. It may be said, however, that *Rhizopus* and especially its zygospores develop best upon nutrients rich in carbohydrates. If agar is used, 4 per cent. to 8 per cent. dextrose will be found a desirable ingredient of any formula. Bread is an ideal substratum but ordinary sterilization renders it pasty and unfit for use. A short sterilization with steam, but not under pressure, continued for less than five minutes will probably be found satisfactory.

The two sexes may be isolated from a culture, producing zygospores by making transfers from individual sporangia to well-separated points in the outer margin of a large dish of some suitable substratum. Zygospores will appear between the growths of oppo-

site sexes. Since one of the sexes may predominate in sporangial growth, the writer has found it a surer method to pick out with fine needles young zygospores free from sporangial spores and to plant them in Petri dishes on nutrient agar. One or both suspensors are likely to grow into mycelia which can be tested out as suggested above.

Inoculation of many sporangial spores causes a dense growth of small sporangia and a reduction of the mycelial growth at the point of inoculation. It is therefore advisable to inoculate only a small number of spores when desiring zygospore production or better yet, to make transfers of the mycelia from fresh tubes of the fungus before they have produced sporangia. In either way the opposite sexes may be sown together or slightly separated so as to cause a somewhat indefinite mass of zygospores where the opposing growths meet. If the nutrient requirements are satisfied and the atmosphere is kept saturated, zygospores may be thus obtained in abundance and nearly free from sporangia.

To teachers on my regular exchange list I am planning to send out dried male and female spore material of *Rhizopus* for use with their classes, together with reprints of the present article. I should also be glad to supply any other teachers with this material who may request it. Cultures should be started from this dried material within a month's time. The male and female cultures may be kept running by transfers to fresh nutrient about every three or four months.

A. F. BLAKESLEE

CARNEGIE STATION FOR
EXPERIMENTAL EVOLUTION,
COLD SPRING HARBOR, L. I., N. Y.

NOTES ON THE FACTORS INVOLVED IN THE GERMICIDAL EFFECT OF FREEZING AND LOW TEMPERATURES

MANY interpretations and conclusions on the germicidal activity of low temperatures and freezing have been given by earlier investigators. Cold was formerly considered a powerful disinfecting agent, but now there is a tendency to emphasize other factors than cold itself as potent. In fact we know that cold may act as a preserver of germ life, as the high bacterial content of frozen food stuffs after weeks and months of refrigeration indicates. Ice, on the other hand, tends to purify itself upon storage.

There are numerous variables which may have an important bearing upon the experiments. A partial list of these includes: (1) The species or strain of bacteria used, (2) the history and cultural manipulation of the organism prior to freezing, (3) the physical and chemical composition of the medium in which the organism is frozen, (4) the temperature of the frozen mixture, (5) the duration of the freezing, (6) the abruptness of temperature changes, (7) the cultivation of the organism subsequent to freezing. This list includes those factors which we took special pains to control.

The bacteria may be killed by the mere fact of low temperature interfering with metabolism; by freezing of the cell contents and rupture of the membrane by internal pressure; by external pressure or grinding developed during crystallization, or by expansion of the frozen medium within the receptacle; or by more or less prolonged suspension of metabolic activities, leading to slow death from old age or starvation.

We shall not take the space to give more than a summary of our preliminary results.

I. The comparative germicidal potency of freezing on different species and strains of bacteria.

B. coli and *B. subtilis* (twenty-four hour old cultures, the latter presumably practically spore-free), showed the former species to be much more susceptible to freezing. Ninety-nine per cent. and over of the *B. coli* succumbed to freezing in tap water in three hours, while with *B. subtilis* the reduction was not at all uniform, but seldom exceeded eighty per cent. Three strains of *B. coli* tested showed no appreciable variability in relation to the disinfecting influence of cold and freezing.[1]

[1] The remainder of our experiments were performed with *B. coli*.

II. The influence of intermittent freezing and thawing upon *B. coli*.

If crystallization is in some way effective in destroying germ life, then alternate freezing and thawing should bring about a greater reduction than prolonged freezing. Table I. shows a part of one of our protocols. It will be noted that intermittent freezing has but slightly greater germicidal value than has sustained freezing for the same period of time.

III. The effect of the degree of cold used in the freezing mixture.

Tubes containing the bacteria were frozen and held for three hours for comparison at approximately —15 degrees C. and —2 degrees C. The colder temperature was considerably more fatal. Tubes kept at +.5 degree C., used as controls in most of the experiments, showed marked variation, but seldom showed over 30 per cent. to 40 per cent. of the bacteria to be killed.

IV. The composition of the media and its influence upon germ survival in freezing mixtures.

It was with the object of studying this feature of the work that we began our experiments. They are still very deficient, but what we have found is worthy of consideration.

Distilled water and Boston tap water give very uniform and comparable results.

Using cream containing 30 per cent. of butter fat, we found very striking protection afforded the bacteria when frozen, whether the freezing be continuous or intermittent. Held at just above the freezing temperature, we find about the same percentage reduction to occur as in water, though the results are very erratic, occasionally showing an increase during the course of a few hours. Freezing and thawing at intervals is considerably more fatal than continuous freezing. A few typical results of freezing *B. coli* in cream are given in the second table.

It is premature to suggest conclusions but our results lead us to infer that the degree of cold, time of freezing, crystallization and external pressure, and the composition of the media in which the freezing occurs all have an influence upon the germicidal potency exhibited by cold. Probably all of the explanations for the mode of destruction, suggested in the early part of these notes, must be considered as important.

TABLE I

A Comparison of the Percentage Reduction of B. coli held at .5° C., —15° C., and Frozen Intermittently for a Three-hour Period

Initial Count	First Freezing	Second Freezing	Third Freezing	Fourth Freezing	Freezing 3 Hours	Cold 3 Hours
2130	82.2%	99.9%	99.9%	99.9%	99.9%	23.0%
16[illegible]0	92.8	96.1	99.8	99.9	99.7	29.0
1320	93.8	98.7	99.9	99.9	99.4	47.0
3015	97.6	99.6	99.5	99.9	99.8	31.3
4800	98.6	99.4	99.8	99.8	99.8	32.0
1370	98.6	99.5	99.8	99.9	99.7	8.1
1070	97.9	99.5	99.5	99.9	99.9	97.3

TABLE II

Percentage Reduction Obtained with B. coli in Cream at Freezing Temperatures

Initial Count	First Freezing	Second Freezing	Third Freezing	Fourth Freezing	Freezing 3 Hrs. 0° C.	Cold 3 Hrs. .5° C.
4350	4.8%	39.3%	45. %	48.9%	61.3%	18.6%
4740	40.5	45.5	71.5	75.9	67.7	42.7
5275	43.1	46.7	71.9	81.2	44.2	16.4
5284	33.4	48.2	60.2	—	26.4	20.8
5028	32.2	36.2	48.4	71.7	34.8	20.6
3732	35.2	20.9	42.3	50.1	33.6	38.9
4030	71.0	67.1	78.6	83.1	67.6	3.9
5085	21.1	51.6	53.3	75.4	65.3	23.8
4725	16.1	36.5	52.2	72.6	58.0	16.8
4560	34.8	47.1	67.4	63.8	54.2	19.7

C. M. HILLIARD,
CHRISTINA TOROSSIAN,
RUTH P. STONE
SIMMONS COLLEGE

SOCIETIES AND ACADEMIES

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE—SECTION OF EDUCATION

THE special summer session of Section L, Education, of the American Association for the Advancement of Science met at the University of California on Tuesday, August 3, and at Stanford University on the following day. The morning meeting on Tuesday was a joint meeting with

Section H and the American Psychological Association. The general subject of the Section's meetings was, "The Scientific Study of Educational Problems."

The joint meeting on Tuesday has already been reported by Dr. J. E. Coover for the American Psychological Association,[1] and need not be reviewed here again. It is worth while noting, however, that the papers all dealt with the application of psychological tests to various groups of individuals. Drs. Grace M. Fernald and Olga L. Bridgman were interested in delinquents; Professor Louis N. Terman in extending the Binet tests; Professor Kate Brousseaux in the feeble-minded; Mrs. V. C. Hicks and Dr. J. E. W. Wallin in mental defectives in the schools; Professor Eleanor Rowland in intelligence tests for college students, and Mr. LeRoy W. Fike in tests for stenographers.

In the afternoon President Wm. T. Foster reported the system of scientific grading in operation at Reed College and explained how credit was awarded for varying grades of quality in the work of the students. Mr. Chas T. Luthy, of Peoria, Ill., reported in considerable detail the mechanism of human speech sound and urged that greater attention be paid this subject, especially on the part of primary and language teachers, so that they might more intelligently understand the mistakes made by their pupils and know how to correct them. The paper by Mr. Walter B. Swift, of Boston, on the "Management of the Speech Defect Problem in the Public Schools" was read by Professor Terman. The acting-secretary read the paper of Mr. Wm. Kent, of Montclair, N. J., on "Elements in the Teaching of Writing." In this paper the writer calls attention to the fact that the difficulty in learning to write is as much due to lack of training of the eye to see errors as it is to lack of ability in executing movements with the hand. He suggested a number of simple exercises by which the eye might be trained in noting defects and in guiding simple movements of the hand before actual practise in writing commenced. Professor Paul H. Hanus's paper, "Measuring Progress in Latin" was also read by the acting-secretary. His paper was a preliminary report on the development of three tests which might indicate progress in Latin. These tests covered vocabulary, grammar and translation. The general scheme was to prepare such tests as might be applied to first-year students and then to have them given in each of the four high-school years. Mr. Wilford E. Talbert called attention in his paper on the "Principal's Study Club of Oakland, Calif.," to what could be done in the way of cooperative research work in a public-school system—Dr. Sears's work, reported below, being mentioned as one example. The program for the day was completed by a paper on "The Vitalizing Principle in Education," by Professor Edward J. Kunze, of the Oakland Agricultural and Mechanical College.

After a very enjoyable morning spent in visiting Stanford University where all were most hospitably entertained, the Section held its concluding session on Wednesday afternoon. Dr. L. W. Sackett, of the University of Texas, presented a very interesting paper on "Measuring a School System by the Buckingham Spelling Scale" in which he showed objectively each school system's standing in spelling—also the standing of each department and grade of each school system. Dr. L. B. Sears, of Stanford University, reported on the "Spelling Efficiency in the Oakland Schools." His general conclusion was that there was no standardization at all. Professor L. Edgar Coover called attention to several of the technical difficulties which still confuse the whole problem of "Formal Discipline." Professor Edward K. Strong, Jr., of George Peabody College for Teachers, reported on several cases in which special instruction had been given fourth-grade children in arithmetic with the result that the children had gained noticeably not only in arithmetic but in other subjects—the gain being due to changes in the child's attitude toward himself. It was suggested that learning curves in arithmetic be employed for this particular purpose. Dr. David S. Hill's paper was a "Survey of Industries in Mechanical Occupations in New Orleans by the Division of Educational Research." Several points were presented dealing with the relationship between occupational needs and industrial and vocational education. He also reported on the work being done in New Orleans in handling the defective child. Mr. Geo. E. Hall, describing an interesting study being made in the Schenectady high schools on "High-school Non-Promotions and Some Factors that Affect them," brought out the point that non-promotion is due not only to incapacity but in many cases to outside interests such as society, clubs or the need to earn money.

Edward K. Strong, Jr.,
Acting-Secretary, Section L

[1] J. E. Coover, Report of Secretary of Committee on Program for San Francisco meeting of the American Psychological Association, *Psychol. Bull.*, September, 1915, 12, 312–332.

SCIENCE

FRIDAY, DECEMBER 3, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE PEDAGOGICS OF PATHOLOGY[1]

IN conformity with the established precedent that the presiding office shall be holden for some remarks in inaugurating his term of service, I venture to present some reflections on the pedagogics of pathology. As members of this society, and of the medical profession, we are all interested in the question of medical education, whether engaged or not in actual teaching. In the curriculum of the medical school, pathology occupies a position of especial interest and importance in relation to the other branches. More than any other topic it bridges the gap which at the present time exists between the sciences fundamental to medicine and the clinical subjects.

Pedagogics—the science of teaching methods—has been making rapid progress in the last half century, and has come to occupy a place among the recognized sciences.

Modern pedagogy is of necessity a recent growth, because experimental psychology itself, upon which it is based, is barely forty years old. The first laboratory for experimental psychology was established by Wundt in Leipsic about 1876, while in this country no such laboratory existed until the one opened by Dr. G. Stanley Hall, at the Johns Hopkins University about 1888. Previous to this time, however, important contributions had been made to the teaching art and the ideas of Pestalozzi, of Herbart, of Rousseau, and others were gradually influencing our educational methods. The importance of laboratory or objective methods, the individual-

[1] Address of the President of the Chicago Pathological Society, October 11, 1915.

ization of teaching by closer attention to the peculiarities of the individual pupil, the splitting of large classes into smaller and smaller groups, the elective plan, the continuous session, best exemplified in the quarter system, research as an essential function of the university and as a pedagogic method, the division of the sciences, particularly, into smaller subdivisions, specialization in a word—these and other pedagogic innovations were, and still are, receiving attention from educators, and are being adopted throughout our educational system from the kindergarten onward. Of special importance were the introduction of objective methods of teaching, in field and laboratory, and the recognition of the individual differences of pupils, with the consequent necessity of adjusting the educational process to these differences by some scheme of election or selection of topic, method and teacher in order to secure the best results.

Laboratory methods began to be introduced into the American colleges—on any extensive scale—not much more than half a century ago, at first in chemistry, then in physics and later in the several biologic branches. The supplanting or supplementing of the older didactic methods of lecture and recitation by these laboratory exercises extended rather rapidly in the literary college, but they made their way much more slowly in the medical school. It might have been expected that the contrary would have been the case when it is recalled that for a century or more one laboratory or practical course, that of human dissection, had occupied a recognized place in the medical curriculum, and was required of every student, but it is barely thirty years since any other laboratory course was generally required in the medical college. It is but little over thirty years since the writer attended the two five-months courses of lectures at that time required for graduation in a medical college of the middle west. Coming from a small university, where even at that time the laboratory exercise constituted the most important feature of instruction in all of the sciences, it seemed strange to find no practical work whatever, aside from dissection and a brief four or five weeks' superficial course in chemistry. A year later, having discovered that he was inadequately prepared, it was decided that he should take another course of lectures, and the choice of an eastern medical college was determined by the fact that it alone, of all of the medical colleges in this country, offered a practical or laboratory course in connection with each of the seven departments—chairs, as they were called—which made up the medical college of that day, namely, anatomy, physiology, chemistry, materia medica, medicine, surgery and obstetrics. Most of these practical courses were brief and superficial, consisting in large part of demonstrations by the teacher rather than of individual work by the student, but they were the beginning of better things.

The explanation of the tardy adoption by the medical faculty of these modern methods is to be found in the fact that its members were not primarily educators, and they were therefore not keeping closely in touch with the advances in pedagogic methods. They were for the most part, even in the fundamental branches, practitioners of medicine for whom the giving of medical lectures two to four times a week during the five or six winter months was an incidental avocation. Not until the medical schools came to have a real, vital connection with the university, and its faculty was brought in close contact with, and came, in part, to be composed of, men who were making teaching the chief, if not the sole business of their lives, was any considerable

progress made in the introduction of more rational and effective methods.

Pathology in my student days was not recognized as an essential subject in the medical curriculum. Indeed at the first college I attended it was not only not taught, but was ridiculed by some of the most influential members of the faculty, as "Deadhouse Medicine." In the second college mentioned, perhaps at that time the most progressive medical college in this country, a few incidental exercises, by a subordinate teacher, who presented some post-mortem specimens to the class, comprised all that was offered. How great has been the advance in the subsequent quarter century is in no wise better illustrated than by the number and character of the contributions made by undergraduate students to the transactions of this society.

Meanwhile, pathology itself has been extending its scope very rapidly. The term pathology no longer stands for mere pathological anatomy, the study of the end results of disease but has come to signify, as its etymology implies, a comprehensive study of the phenomena of disease in the living, the behavior of cells, tissues, organs and systems, in an abnormal environment, or their reaction to abnormal stimuli—an exhaustive search for the causes of these abnormalities, physical, chemical and biologic, and the rationale of the processes by which these etiologic factors bring about the phenomena which we call disease. Indeed, some of the more recent text-books on medicine include, under the heading of pathology, the discussion of etiology, symptomatology, pathogenesis and pathologic anatomy, everything, in short, but diagnosis, prognosis and therapy.

The methods by which this comprehensive knowledge is sought are more and more becoming the methods of exact, carefully controlled experiment on animals. The mere study of post-mortem changes, important though it is, comes yearly to occupy a relatively less important rôle in the task of the pathologist. Infection and immunity, serology, protozoology, chemical pathology, these and other phases of the subject, newly born in the last decade or two, are rapidly changing our whole conception of pathology, are greatly enlarging its scope, and are, as it seems to me, necessitating a constant readjustment of this branch to other branches in the medical curriculum, and improvements in our methods of instruction by which the coming generation of practitioners must be educated in pathology.

The pedagogics of pathology involves a consideration of (1) its relative importance in the curriculum—that is, the number of scheduled hours that should be assigned to the subject; (2) its proper sequence in the program of courses to be determined by the prerequisites which are essential for its intelligent study, and by its relation to the more advanced clinical subjects for the pursuit of which some knowledge of pathology is necessary, and (3) the methods to be employed in the teaching of the subject, and this depends largely on one's conception of the scope and content of pathology as a science.

A survey of the curricula of about forty of the leading university medical schools of the United States discovers the fact that while there are considerable variations in the courses in pathology offered in these schools, as to the three points just mentioned, on the whole the differences are less marked than are those in the clinical subjects.

The amount of time assigned to the subject is somewhat difficult to determine, as some of the topics taught in most schools under the general heading of pathology, are offered in others in connection with bacteriology, while other topics, for example,

laboratory or clinical diagnosis, are taught in the department of medicine or in other clinical departments. As nearly as can be estimated the time allotted to pathologic topics ranges from 210 hours in one school to a maximum of 504 hours in the University of Ohio.

One of the most conclusive evidences that up to 8 or 10 years ago the principles of pedagogy were little understood or regarded by medical faculties, was the great diversity in the number of hours assigned to the several medical branches. You will recall the rather startling findings of the investigations made as to this matter a decade ago by the secretary of the Michigan State Board of Medical Examiners, the president of the Illinois State Board of Health, and by the Council on Medical Education of the American Medical Association. It was found that the number of scheduled hours assigned to some of the important medical subjects varied by as much as three or four hundred per cent., and that some of the minor subjects, for example, orthopedic surgery, occupied as much of the student's time in some colleges as a major branch like medicine or general surgery.

It is obvious that these curricula were not prepared with any logical consideration of the relative values of the medical branches. Each instructor, impressed with the magnitude of his own subject, clamored for more and more time, insisting that he could not "cover the ground" of his branch of medicine in any number of hours that could in reason be given over to it in a four-year course of study. The construction of a medical curriculum from the point of view of the average student's working capacity and the logical division of his total working hours between the several branches in ratio to their relative importance to the medical practitioner seems not to have been attempted until a very recent period.

When the problem is approached from this standpoint it becomes at once evident that by no possible scheme can such a number of scheduled hours be allotted to any branch as will make it possible for the instructors to completely "cover the ground" of that branch. The task of each department is to make such use of the number of hours assigned to it, by faculty vote, as will secure to each student the largest possible educational result for the expenditure of that time in the given topic. With a curriculum blocked out on such a basis, pathology can not logically demand more than 8 or 9 per cent.—together with bacteriology not to exceed 12 per cent.—of the total number of scheduled hours in the four years' course of study; as this total in the average medical school is approximately 4,400 hours, the time assigned to pathology should not exceed 350 or 400 hours.

I find that the average allotment to the courses in pathology in the curricula of the forty colleges which I have examined is about 350 hours, although there are a few marked exceptions. The time allotted to bacteriology ranges from about 100 to 200 hours, with an average of 150, thus making a total for the two subjects fairly proportionate to their importance in relation to the other branches of the medical curriculum.

The logical sequence of the medical subjects is determined by certain fundamental pedagogic principles.

The study of structure logically precedes the study of function; knowledge of the normal is essential to an understanding of the abnormal, although the study of the latter often yields valuable information about the normal; a broad knowledge of the principles, facts and methods of any growing science to specific problems, as those of medicine, is an indispensable prerequisite if the student is to be so grounded

in that science as to be able to keep abreast with its progress after his student days. It is a fatal error to present the fundamental medical sciences with too exclusive reference to their practical application to medicine and surgery, although the occasional illustration of the bearing of anatomy, physiology, pathology, etc., on their practical application to clinical medicine is of distinct advantage. With these principles in mind the position of pathology in the medical curriculum is not difficult to determine. There is a rather striking uniformity in the place assigned to bacteriology and pathology in the courses of study in the several colleges. In the majority of colleges bacteriology is offered in the first semester of the second year, followed by general pathology in the second semester, and by special pathology, with autopsies, in the third year. In a few institutions bacteriology is given in the first year, and in two instances pathology proper is begun at this time. In a number of colleges advanced pathology with autopsies, and special topics such as surgical, gynecologic, neurologic and dermatologic pathology are continued into the senior year.

Bacteriology, it seems to me, might, with advantage, be divided into two parts, general bacteriology, with laboratory technique, being given in the first year, or better still, required for admission, to be followed by a briefer course in the pathogenic bacteria, and in infection and immunity, in the second year—preferably the first semester. The fundamental course is an excellent one for the beginning student, no work in the other sciences being prerequisite for the intelligent study of the subject, and the laboratory technique affording a good training for the laboratory exercises in the other branches. It seems impracticable to crowd such a course into the two years of premedical work at present demanded by most schools, but it is probable that this minimum amount can, before long, be extended to three years, and thus provide time for bacteriology.

The position of general pathology in most curricula is as it should be. It secures to the student the necessary preparation in anatomy, gross and microscopic, embryology, physiology, biologic chemistry and bacteriology, and, on the other hand, links these subjects closely to the clinical branches. I would urge, however, the importance of placing pathologic anatomy with autopsies later than is now done in many schools. The student should have acquired some considerable first-hand knowledge of the phenomena of disease in the living patient before he studies the final outcome of serious disease as disclosed at the autopsy, and as often as possible he should follow the individual patient, dying from some affection, which he has observed in life, to the post-mortem table. Of especial educational value is the study of a few cases, seen at autopsy, exhaustively, by every feasible method of examination, as contrasted with a second-hand survey of the whole field of pathologic anatomy by lecture, text-book and recitation. One of our members, not long since, described his own method of conducting such a course, which seems to me in every way commendable.

May I, in this connection, comment on the singular and widely prevalent perversity with which teachers in all lines and grades of education in this country are prone to get away, in their practise, from the fundamental idea and purpose of education?

Its primary purpose is to develop the mental facilities, *not* to impart information. And this is quite as true of medical as of any other kind of education. That the pupil shall be educated, trained to observe

accurately, and thoroughly, to record his observations clearly and concisely, and to reason logically from his findings to sound deductions—*that* is the main purpose and function of any educational process, be it medical, pathologic or any other. We in America seem especially obtuse in our failure to recognize this vital truth, as is shown conspicuously in the character of our examinations. We have made some progress in our teaching methods, though we have yet much to learn, but we continue to test the results of our work by methods a half century out of date. In examinations for graduation, for licensure to practise (with exceptions now in a few states) and in competitive examinations for interneships in the best hospitals, the papers set are wholly written papers of such sort as to test only the volume of facts which the candidate has been able to cram into his cranium—a test, in other words, of but one mental faculty, the memory, and that by no means the most important. Into the student's real power to see and hear and feel things, to know what he observes, and to draw sound conclusions from his findings—in short his ability to *do* the things he is to be called upon to do as an interne and a practitioner of medicine, we make no real inquiry whatever. If we are to give our students the proper conception of what they are attending the medical school for, and an effective stimulus to really develop all of their mental faculties, along medical lines, we must radically change the character of our examinations.

The teachers of pathology are in an especially advantageous position to set an example in this regard, and to exert a profound influence for the betterment of our methods of examination.

Another serious mistake is the growing tendency to crowd some of the clinical subjects into the sophomore year. In one school, for example, courses in medicine, surgery, obstetrics, ophthalmology and dermatology now occupy a considerable portion of the time of the second semester of the sophomore year; at another, the sophomores take medicine, both clinical and didactic, surgery and pediatrics; at a third school, medicine, surgery, obstetrics and dermatology occupy 10 hours weekly of the 25 or 30 available, while in yet another, medicine, surgery and obstetrics are begun at this time. The time available for the fundamental sciences of anatomy, general pathology, etc., is all too short when the full time of the two years is devoted exclusively to them. The education which the student is obtaining in these fundamental subjects in these two years is the only systematic instruction he will ever get in those branches, and must serve him for a life time. Most students leave the medical college at graduation with a resolve to review these branches from time to time, but very few indeed ever do so. Deficiencies in clinical training are readily amended, because the subjects are right in line with the physician's daily work; shortcomings in the fundamental branches can be corrected only at a considerable sacrifice of time, money and energy.

I have indicated that I would lay much less stress on pathologic anatomy than has been and still continues to be the custom in most schools, and more, increasingly more, time on experimental pathology, chemical pathology, serology, and the other newer developments of the subject. As to pathologic anatomy much can be done to familiarize students with the gross and microscopic appearance of diseased tissues and organs (and this with the minimum expenditure of effort by both student and teacher) by having displayed in a well-lighted central place, frequented by the student body for study or lounging, patho-

logic specimens, plates, drawings, charts and other illustrative materials. In idle moments one can accumulate a large amount of information by this means. It is the height of stupidity to lock up material of this sort in dark inaccessible cases, to be brought forth only on special occasions.

There is need, in most schools, of a better correlation between the department of pathology and the clinical departments. The clinical teachers are, for the most part, busy practitioners having little time, even when they have the inclination, to keep in touch with what is going on in the pathological department so as to command the resources of its museum in their clinical teaching. The instructors in pathology can accomplish a great deal to secure more thorough and accurate presentation of the pathologic side of the clinical subjects if they are constantly calling the attention of the clinicians to the materials in their museums and laboratories, and are themselves available at convenient hours to respond to a summons to the medical, surgical or other clinic to demonstrate pathologic specimens, illustrative of the topic being presented, or the clinical patient who is being shown, and to explain the newer, more refined laboratory methods of diagnosis.

No colleague of mine would think it possible for me to get through a discussion on an educational topic without allusion to the elective system. I should be sorry to disappoint any one, or to lose such an opportunity. May I say then first, that after fifteen years of experience and observation I am more confirmed in my belief than ever before, of its applicability to, and its advantage, with suitable restrictions, in medical education. The elective principle has been adopted, and is in operation, in one form or another, in every college and university of any importance in this country. It has been an integral part of the educational system in the German, and most other foreign universities, in the medical as well as in other departments, for over fifty years. I have elsewhere described the plan and discussed its advantages in the medical curriculum at length, and do not here purpose to review that discussion. However, to correct certain erroneous impressions, which seem to be quite prevalent, may I say that the elective system, properly administered, does not mean the unrestricted freedom of the student to do just as he pleases—to choose any course of study which strikes his fancy. Its chief advantages do *not* lie in the choice of branches or even of topics, but much more in the choice of methods of study—by lecture, recitation, laboratory, clinic, research—and of the instructor under whom each course is to be pursued. Its purpose in the medical school is *not*, or should not be, to encourage or even to permit, the undergraduate student to follow a restricted course of study in preparation for a special line of practise, although in this form it is in operation, mistakenly, as I believe, in two or three of our leading medical schools. It does *not* mean, for example, that any student should be permitted to neglect pathology, or medicine or any special clinical subject. It *does* make for his opportunity to get the minimum amount to be required of that subject by the method and under the instructor that will insure for him the best training, that is the maximum educational gain in that branch of study, and it should permit and encourage him to pursue that subject much beyond the minimum amount required for graduation, if he finds therein, as very many students do, the best medium for developing his powers of observation and reasoning.

As surely as individuals differ, as they do differ widely, in mental equipment and

capacity, just so surely can we obtain the best results in education only by such elasticity in our methods as makes possible the adjustment of the educational procedure to each student's capacity, peculiarities and needs.

And finally, I would speak for a much wider adoption and extension of the method of research in medical education. The daily practise of medicine, for which we are preparing most of our pupils, is research of the highest order and the most difficult type. We train the neuro-muscular apparatus and the special senses to efficiency in any particular direction, by their constant exercise in that activity or direction. How can we better train the mental facilities for research at the bedside than by their exercise in research, in laboratory and clinic? No one would deny that a certain body of fundamental facts and principles must be memorized by every medical student, and facility in certain technical procedures ought to be acquired, but if we hope to arouse in the student a real enthusiasm for his work, and to develop his power of independent initiative and accomplishment in the setting and the solving of problems, it can be done only—certainly most effectively—by setting him to the task of solving problems within his capacity, involving factors within his control, his work being carried on under intelligent, wise supervision. The problems of pathology are peculiarly well adapted for this purpose. They may be so selected as to have to do with materials and factors within the scope of his ability and training, and they are of interest to him because he can readily see their bearing on clinical medicine, for which he feels he is fitting himself. If he is to have zeal in their pursuit, however, it must not be the threshing over of old straw, but new problems whose solution he feels may constitute a real contribution, however small, to medical science. If he can then present the results of his efforts to a dignified, earnest group of his elders, such as assemble at the meetings of this society, it means for him a generation of enthusiasm, a development of real power, such as no other educational method can produce.

This society has great reason to be proud of the subsequent work of many men and women who found here their first opportunity and their best inspiration. It is certain to have increasing cause for gratification, as the years go on, in the results of this phase of its activities.

JOHN MILTON DODSON

PLANT MORPHOLOGY[1]

I PROPOSE to deal with some aspects of the study of plant morphology. In doing so I shall not accept any definition of morphology that would separate it artificially from other departments of botany. I regard the aim of plant morphology as the study and scientific explanation of the form, structure, and development of plants. This abandons any sharp separation of morphology and physiology, and claims for morphology a wider scope than has been customary for the past fifty years. During this period the problem of morphology has been recognized as being "a purely historical one," "perfectly distinct from any of the questions with which physiology has to do," its aim being "to reconstruct the evolutionary tree." The limitation of the purpose of morphological study, expressed in these phrases from the admirable addresses delivered to this section by Dr. Scott and Professor Bower some twenty years ago, was due to the in-

[1] From the address of the president of the Section of Botany, Manchester meeting of the British Association for the Advancement of Science.

fluence of the theory of descent. I fully recognize the interest of the phyletic ideal, but am unable to regard it as the exclusive, or perhaps as the most important, object of morphological investigation. To accept the limitation of morphology to genealogical problems is inconsistent with the progress of this branch of study before the acceptance of the theory of descent, and leaves out many of the most important problems that were raised and studied by the earlier morphologists.

In the history of morphology, after it had ceased to be the handmaid of the systematic botany of the higher plants, we may broadly distinguish an idealistic period, a developmental period, and a phyletic period. The period of developmental morphology, the most fruitful and the most purely inductive in our science, was characterized by an intimate connection between morphological and physiological work. Among its contributions were studies of development or "growth histories" of whole plants and their members. These were carried out, in part at least, in order to investigate the nature of development, and such general problems found their expression at the close of the period in the "Allgemeine Morphologie" of Hofmeister. The "Origin of Species" took some years before it affected the methods and aims of botanical work. Then its effect on morphology was revolutionary, and, as in all revolutions, some of the best elements of the previous *régime* were temporarily obscured. This excessive influence of the theory of descent upon morphology did not come from Darwin himself, but from his apostle Haeckel, who gave a very precise expression to the idea of a genealogical grouping of animals and plants, illustrated by elaborate hypothetical phylogenetic trees. Such ideas rapidly dominated morphological work, and we find a special "phylogenetic method" advocated by Strasburger. The persistence of the phyletic period to the present time is shown, not only in the devotion of morphology to questions of relationship, but in the attempts made to base homologies upon descent only. Lankester's idea of homogeny can be traced to the influence of Haeckel, and nothing shows the consistency of phyletic morphology to its clear but somewhat narrow ideal so plainly as the repeated attempts to introduce into practise a sharp distinction between homogeny and homoplasy.

Professor Bower, in his address last year and in other papers, has dealt illuminatingly with the aims and methods of phyletic morphology. I need only direct attention to some aspects of the present position of this, which bear on causal morphology. The goal of phyletic morphology has throughout been to construct the genealogical tree of the vegetable kingdom. In some ways this seems farther off than ever. Phyletic work has been its own critic, and the phylogeny of the genealogical tree, since that first very complete monophyletic one by Haeckel, affords a clear example of a reduction series. The most recent and trustworthy graphic representations of the inter-relationships of plants look more like a bundle of sticks than a tree. Consider for a moment our complete ignorance of the inter-relationships of the Algæ, Bryophyta, and Pteridophyta. Regarding the Algæ we have no direct evidence, but the comparative study of existing forms has suggested parallel developments along four or more main lines from different starting-points in a very simple unicellular ancestry. We have no clue, direct or indirect, to the ancestral forms of the Bryophyta, and it is an open question whether there may not be as many

parallel series in this group as in the Algæ. The Pteridophyta seem a better case, for we have direct evidence from fossil plants as well as the comparison of living forms to assist us. Though palæobotany has added the Sphenophyllales to the existing groups of vascular cryptogams and has greatly enlarged our conceptions of the others, there is no proof of how the great groups are related to one another. As in the Bryophyta, they may represent several completely independent parallel lines. There is no evidence as to what sort of plants the Pteridophyta were derived from, and in particular none that relates them to any group of Bryophyta or Algæ. I do not want to labor the argument, but much the same can be said of the seed-plants, though there is considerable evidence and fairly general agreement as to some Gymnosperms having come from ancient Filicales. The progress of phyletic work has thus brought into relief the limitations of the possible results and the inherent difficulties. As pointed out by Professor Bower, we can hope for detailed and definite results only in particularly favorable cases, like that of the Filicales.

The change of attitude shown in recent phyletic work towards "parallel developments in phyla which are believed to have been of distinct origin" is even more significant. Prof. Bower spoke of the prevalence of this as an "obstacle to success," and so it is if our aim is purely phyletic. In another way the demonstration of parallel developments constitutes a positive result of great value. Thus Professor Bower's own work has led to the recognition of a number of series leading from the lower to the higher Filicales. By independent but parallel evolutionary paths, from diverse starting-points in the more ancient ferns, such similarity has been reached that systematists have placed the plants of distinct origin in the same genus. In these progressions a number of characters run more or less clearly parallel, so that the final result appears to be due "to a phyletic drift that may have affected similarly a plurality of lines of descent." This conclusion, based on detailed investigation, appears to me to be of far-reaching importance. If a "phyletic drift" in the ferns has resulted in the independent and parallel origin of such characters as dictyostely, the mixed sorus, and the very definite type of sporangium with a vertical annulus and transverse dehiscence, the case for parallel developments in other groups is greatly strengthened. The interest shifts to the causes underlying such progressive changes as appear in parallel developments, and the problem becomes one of causal morphology rather than purely historical.

The study of parallel developments would, indeed, seem likely to throw more light on the morphology of plants than the changes traced in a pure phyletic line, for it leads us to seek for common causes, whether internal or external. We cease to be limited in our comparisons by actual relationship, or forbidden to elucidate the organization in one group by that which has arisen independently in another. Similarly the prohibition against comparing the one generation in the life-cycle with the other falls to the ground, quite apart from any question of whether the alternation is homologous or antithetic. The methods of advance and the causal factors concerned become the important things, and if, for example, light is thrown on the organization of the fern-plant by comparison with the gametophyte of the moss, so much the better. This, however, is frankly to abandon phylogeny as "the only real basis of morphological study,"

and with this any attempt to base homology on homogeny. Many of the homologies that exist between series of parallel development are what have been happily termed homologies of organization; these are sometimes so close as to result in practical identity, at other times so distinct as to be evident homoplasies. The critical study of homologies of organization over as wide an area as possible becomes of primary interest and importance.

Since about the beginning of the present century a change of attitude towards morphological problems has become more and more evident in several ways. It seems to be a phyletic drift affecting simultaneously a plurality of lines of thought. The increasing tendency to look upon problems of development and construction from a causal point of view is seen in the prominence given to what may be termed developmental physiology, and also in what Goebel has called organography. These deal with the same problems from different sides and neither formulates them as they appear to the morphologist. Together with genetics, they indicate the need of recognizing what I prefer to call general or causal morphology.

The problems of causal morphology are not new, though most of them are still unsolved and are difficult to formulate, let alone to answer. As we have seen, they were recognized in the time of developmental morphology, though they have since been almost wholly neglected by morphologists. So far as they have been studied during the phyletic period, it has been from the physiological rather than the morphological side. Still, such problems force themselves upon the ordinary morphologist, and it is from his position that I venture to approach them. I willingly recognize, however, that causal morphology may also be regarded as a department of plant-physiology. In development, which is the essential of the problem, the distinction between morphology and physiology really disappears, even if this distinction can be usefully maintained in the study of the fully developed organism. We are brought up against a fact which is readily overlooked in these days of specialization, that botany is the scientific study of plants.

General morphology agrees with physiology in its aim, being a causal explanation of the plant and not historical. Its problems would remain if the phyletic history were before us in full. In the present state of our ignorance, however, we need not be limited to a physico-chemical explanation of the plant. Modern physiology rightly aims at this so far as possible, but, while successful in some departments, has to adopt other methods of explanation and analysis in dealing with irritability. It is even more obvious that no physico-chemical explanation extends far enough to reach the problems of development and morphological construction. The morphologist must therefore take the complicated form and its genesis in development and strive for a morphological analysis of the developing plant. This is to attack the problem from the other side, and to work back from the phenomena of organization toward concepts of the nature of the underlying substance.

It is to these questions of general morphology with a causal aim (for causal morphology, though convenient, is really too ambitious a name for anything we yet possess) that I wish to ask your attention. All we can do at first is to take up a new attitude towards our problems, and to gather here and there hints upon which new lines of attack may be based. This new attitude is, however, as I have pointed

out, a very old one, and in adopting it we re-connect with the period of developmental morphology. Since the limited time at my disposal forbids adequate reference to historical details, and to the work and thought of many botanists in this field, let me in a word disclaim any originality in trying to express in relation to some morphological problems what seems to me the significant trend, in part deliberate and in part unconscious, of morphology at present. The methods available in causal morphology are the detailed study in selected plants of the normal development and its results, comparison over as wide an area as possible, with special attention to the essential correspondences (homologies of organization) arrived at independently, the study of variations, mutations, and abnormalities in the light of their development, and ultimately critical experimental work. This will be evident in the following attempt to look at some old questions from the causal point of view. I shall take them as suggested by the fern, without confining my remarks to this. The fern presents all the main problems in the morphology of the vegetative organs of the higher plants, and what little I have to say regarding the further step to the seed-habit will come as a natural appendix to its consideration.

Twice in its normal life-history the fern exhibits a process of development starting from the single cell and resulting in the one case in the prothallus and in the other in the fern-plant. For the present we may treat these two stages in the life-history as individuals, their development presenting the same general problems as a plant of, say, Fucus or Enteromorpha, where there is no alternation of generations. How is the morphologist to regard this process of individual development?

In the first place, we seem forced to regard the specific distinctness as holding for the germ as well as the resulting mature plant, however the relation between the germ-cell and the characters of the developed organism is to be explained. We start thus with a conception of specific substance, leaving it quite an open question on what the specific nature depends. This enables us to state the problem of development freed from all considerations of the ultimate uses of the developed structure. The course of development to the adult condition can be looked upon as the manifestation of the properties of the specific substance under certain conditions. This decides our attitude as morphologists to the functions of the plant and to teleology. Function does not concern us except in so far as it is found to enter as a causal factor into the process of development. Similarly, until purpose can be shown to be effective as a causal factor it is merely an unfortunate expression for the result attained.

Let me remind you, also, that the individual plant, whether it be unicellular, cœnocytic or multicellular, may behave as a whole at all stages of its development. We see this, for instance, in the germination of *Œdogonium,* in the germination and subsequent strengthening of the basal region in *Fucus* or *Laminaria,* in the moss-plant or fern-plant, or in a dicotyledonous tree. A system of relations is evident in the plant, expressed in the polarity and the mutual influences of the main axis and lateral branches, as well as in the influences exerted on the basal region by the distant growing parts. We thus recognize, in its most general form, the correlation of parts, a concept of proved value in botany.

To some the expression of the observed facts in this way may appear perilously mystical. I do not think so myself. It is true that the nature of the specific substance and of the system of relations is un-

known to us, but it is regarded as a subject for scientific inquiry and further explanation. To recognize fully the complexity of the substance of the plant is not, however, a step towards neo-vitalism, but is perhaps our best safeguard against the dangers of this.

The wholeness of the individual, together with important phenomena of regeneration, has suggested the conclusion that something other than physico-chemical or mechanical laws are concerned in the development of the organism. To this something Driesch applies the name entelechy. Without discussing the vitalistic philosophy of the organism, or other modern phases of philosophic thought that treat life as an entity, it seems worth while to point out that they are based mainly on the consideration of animal development. It would be interesting to inquire into the difficulties that are met with in applying such views to plants, where regeneration in one form or another is the rule rather than the exception, and often does not lead to restitution of the individual. Causal morphology can recognize phenomena of development and of the individual, which are at present beyond physico-chemical explanation, and try to attack them by any methods of investigation that seem practicable, without begging the main question at the outset and then proceeding deductively. To assume any special inner director of development, be it entelechy or vital force, is to cut the knot that may ultimately be untied.

The previous experience of botany in the time of nature-philosophy may well make us cautious of solving our difficulties by the help of any new biological philosophy. On the other hand, cooperation between biology and philosophic thought is highly desirable. In this connection I should like to refer to an idea contained in Prof. Alexander's paper on the basis of realism. He suggests that there is only one matrix from which all qualities arise, and that (without introducing any fresh stuff of existence) the secondary qualities, life, and at a still higher level, mind, emerge by some grouping of the elements within the matrix. The development of this idea as it applies to life would appear to offer a real point of contact between inductive biological work and philosophy.

To return to our plant, its development, with increase in size and progressive complexity of external form and internal structure, must be considered. The power of continued development possessed by most plants and wanting in most animals makes comparison between the two kingdoms difficult. That there is no fundamental difference between the continued and the definitely limited types of embryogeny is, however, shown by plants themselves. The bryophyte sporogonium is a clear example of the latter, while the fern sporophyte is one of many examples of the former. A difference less commonly emphasized is that in the sporogonium (as in the higher animals) the later stages of development proceed by transformation of the whole of the embryo into the mature or adult condition; in the fern-plant the apical development results in successive additions of regions which then attain their mature structure by transformation of the meristematic tissue.

These distinctions are of some importance in considering the generalization originally founded on animal development and known as the biogenetic law. That "the ontogeny is a concise and compressed recapitulation of the phylogeny" is essentially a phyletic conception. It has been more or less criticized and challenged by some distinguished zoologists, and has always been difficult to apply to plants. If we avoid being prejudiced by zoological theory and results, we do not find that the characters of the em-

bryos of plants have given the key to doubtful questions of phylogeny. What help do they give us, for instance, in the algæ or the vascular cryptogams? The extension of the idea of recapitulation to the successively formed regions of the seedling plant requires critical examination; if admitted it is at any rate something different from what the zoologist usually means by this. The facts—as shown, for instance, in a young fern-plant—are most interesting, but can perhaps be better looked at in another way. Development is accompanied by an increase in size of the successively formed leaves and portions of stem, and the process is often cumulative, going on more and more rapidly as the means increase until the adult proportions are attained. The same specific system of relations may thus find different expression in the developing plant as constructive materials accumulate. I do not want to imply that the question is merely a quantitative one; quality of material may be involved, or the explanation may lie still deeper. The point is that the progression is not a necessary one due to some recapitulative memory.

There are some other classes of facts, clearly cognate to normal individual development, that seem to require the causal explanation. I may mention three: (1) Vegetatively produced plants (from bulbils, gemmæ, etc.) tend in their development to pass through stages in elaboration similar to young plants developing from a spore or zygote. The similarities are more striking the smaller the portion of material from which a start is made. (2) Branches may repeat the stages in ontogeny more or less completely also in relation to differences in the nutritive conditions. (3) In the course of continued development there may be a return to the simpler form and structure passed through on the way to the more complex. These cases of parallels to, or reversals of, the normal ontogenetic sequence suggest explanation on causal lines, but are difficulties in the way of phyletic recapitulation; the first two cases can be included under this, while the third seems definitely antagonistic. On the whole, it may be said that recapitulation can not be accepted for plants without further evidence, and that preliminary inquiry disposes us to seek a deeper and more fruitful method of explaining the facts of development.

The development of most plant-individuals starts from a single cell, and when we compare mature forms of various grades of complexity the unicellular condition is also our usual starting-point. What is not so generally recognized or emphasized is the importance of the filament as the primitive construction-form of most plants. I do not use the word primitive in a phyletic sense, nor in the sense of an ideal form, but to indicate a real stage in independent progressions underlying many homologies of organization. I can not develop this fully here, but wide comparison of independent lines of advance suggests that the main types of progress in complexity of the plant-body have involved the elaboration of the single filament with apical growth and with subordinated "branches." It is generally recognized that various groups of algæ show how a solid multicellular axis may come about, not only by the further partition of the segments of the apical cell, but by the congenital cortication of a central filament or the congenital condensation of the subordinated "branches" on to the central axis. The algæ further show the change from the dome-shaped apical cell of a filament to the sunken initial cell with two, three or four sides. The central filament then only appears, if at all, as a subsequent differentiation in the tissue, and the segments serially cut off from the apical cell may or may not bear projecting hair-shoots

or "leaves." The algæ thus attain in independent lines a construction corresponding to that of the plant in liverworts and mosses. In the various parallel series of Bryophyta the filament is not only more or less evident in the ontogeny, but may be regarded as the form underlying both thallus and shoot, between which on this view there is no fundamental distinction. The sporogonium also can be readily regarded as an elaborated filament. While the same interpretation of the fern-prothallus will readily be granted, to think of the fern-plant as the equivalent of an elaborated filament may appear far-fetched. So far from this being the case, I believe that it will be found helpful in understanding the essential morphology of the shoot. In a number of vascular cryptogams and seed-plants, there is actually a filamentous juvenile stage, the suspensor, while the growth by a single apical cell is essentially the same in the fern as in the moss and some algæ.

There follows from this a natural explanation of the growth by a single initial cell so commonly found in plants. The apical cell appears to be the one part of the massive plant-body (for instance, of Laurencia, a moss, or a fern) that persists as a filament; it is a filament one cell long. It may be replaced by a group of initial cells, as we see in some algæ, liverworts and Pteridophyta, and this leads naturally to the small-celled meristems found in most Gymnosperms and Angiosperms. The filamentous condition is then wholly lost, though the system of relations and especially the polarity is maintained throughout all the changes in the apical meristem.

I feel confirmed in regarding the construction of the sporophyte in this fashion by the fact that it fits naturally with the conclusions resulting from the masterly comparative treatment of the embryology of the vascular cryptogams by Professor Bower. These are (1) the primary importance of the longitudinal axis of the shoot, the position of the first root and the foot being variable; (2) the constancy of the position of the stem-apex near the center of the epibasal half of the embryo; (3) the probability that embryos without suspensors have been derived from forms with suspensors, without any example of the converse change. These and other related facts seem to find their morphological explanation in the shoot of the sporophyte being the result of the elaboration of a filament.

The view to which we are thus led is that the uniaxial shoot is a complex whole, equivalent to the axial filament together with its congenitally associated subordinated "branches." This applies to the multicellular plant-bodies found in various independent lines of algæ and Bryophyta, whether they have definite projecting appendages of the nature of leaves or not. The discarding of the distinction between thallus and shoot, which in practise has proved an unsatisfactory one, is no great loss. Even taking the word in the narrower sense of a stem with distinct leaves, the shoots in algæ, liverworts, and mosses, though admittedly independent developments, exhibit an essential correspondence amounting to a homology of organization. The resemblances are not analogies, for it is doubtful whether the "leaves" in the different cases correspond in function. The comparison of the shoot of the sporophyte of a vascular cryptogam with, for example, the shoot of the moss seems equally justifiable. It is only forbidden by strict phyletic morphology, which for our purpose has no jurisdiction. The general agreement as regards the leaf-arrangement between the ferns and the Bryophyta suggests that similar laws will be found to hold in the shoot of both gametophyte and sporophyte. Apart from plagiotropic

shoots, there is a constructionally dorsiventral type of fern-rhizome. The leaves of this alternate as in the leafy liverworts, while the radial type of fern corresponds to the moss-shoot. It is significant that the early leaves of radially constructed ferns usually exhibit a divergence of $\frac{1}{3}$ in the seedling, passing higher up the stem into more complicated arrangements, and the same is the case in mosses. I must not enter into questions of phyllotaxy, but may remark on the hopefulness of attacking it from the study of the simpler shoots of algæ and Bryophyta rather than, as has usually been done, beginning with the flowering plants.

In some ferns (the striking example being *Ceratopteris*) the relation between the segmentation of the apical cell and leaf-production is as definite as in the moss, each segment giving rise to a leaf. This may hold more widely for ferns than is at present demonstrated, and the question deserves thorough reinvestigation to ascertain the facts independently of any theoretical views. That the coincidence of the segmentation of the shoot expressed by the leaf-arrangement and the segmentation of an apical cell is not a necessary one is, however, clearly shown in other ferns, and is obvious in the case of shoots with a small-celled meristem. The two segmentations appear to be determined by some deeper system of relations, which may also be manifested in a cœnocytic plant-body.

In the complication of the uniaxial shoot introduced by branching also there seems to be an advantage in a wide area of comparison. The question most often discussed concerns dichotomous and monopodial branching. If the details of development are to be taken into consideration, the term "dichotomy" has usually been very loosely applied. Apparent dichotomy, the continuation of one shoot by two equally strong ones, is fairly common. But in most cases investigated in detail the branching seems to be really monopodial and the forking due to the equally strong development of a lateral branch close to the main apex, not to the division of the latter. In plants growing by a single initial cell almost the only case of strict dichotomy known is the classic one of Dictyota. The branching of the ferns has been the subject of numerous investigations, but there is a great lack of developmental data. Usually the branches stand in some definite relation to the leaves of the shoot, behind, to one side, or on the leaf-base, itself, the most interesting but least common case being when the branch is in an axillary position. When the mature shoot only is considered, it is possible to argue for the derivation of monopodial branching from dichotomy or the converse. Even the facts obtainable from the mature plant, however, point to the dichotomous branching being a modification of the monopodial, the opposite view appearing to land us in difficulties regarding the morphology of the main shoot. It is unlikely that a dichotomy involving the division of the apical cell occurs in the fern-shoot, and comparison with the Bryophyta confirms the suspicion that the cases of dichotomy are only apparent.

In considering the construction of the shoot we are at present limited to comparison of the normal structure and development. The system of relations in the shoot of the fern, affecting in the first place the distribution of the leaves and secondly that of the branches, appears, however, to be of the same nature as in the independently evolved shoots of Bryophyta and algæ. A morphological analysis based on the simpler examples may lead on to the experimental investigation of the com-

mon construction. The relation that exists between the general construction and the vascular anatomy offers a special and more immediately hopeful problem. Here also, in considering the fern, we are assisted by homologies of organization in other vascular cryptogams and in the more complex Bryophyta, though the algæ are of little help.

In few departments of botany has our knowledge increased so greatly and become so accurate as in that of vascular anatomy. The definiteness of the structures concerned and the fact that they have been almost as readily studied in fossil as in living plants has led to this. Not less important have been the clear concepts first of the bundle system and later of the stele under which the wealth of fact has been brought. Great progress has been made under the influence of phyletic morphology, and anatomy has adopted further conventions of its own and tended to treat the vascular system as if it had an almost independent existence in the plant. The chief method employed has been the comparative study of the mature regions, of necessity in the fossils and by choice in the case of existing plants. I do not. of course, mean to say that we are ignorant of the development of the vascular system, but the variety in it has not been adequately studied in the light of apical development. A gap in our knowledge usually comes between the apical meristem itself and the region with a developed vascular system. It is in this intermediate region that the real differentiation takes place, and the arrangement of the first vascular tracts is then modified by unequal extension of the various parts. The apical differentiation requires separate study for each grade of complexity of the vascular system, even in the same plant.

If we look at the vascular system, not as if it had an independent existence or from the phyletic point of view, but as a differentiation taking place within the body of the individual plant, we can inquire as to the causal factors in the process. A deeper insight into the nature of the stele may be obtained by regarding it as the resultant of a number of factors, as part of the manifestation of the system of relations in development. The first step towards this is the critical consideration of normal developing plants, but so long as the causal influences in the developing substance of a plant remain unchanged the resulting vascular structure will remain constant. Our hope of advance lies in the study of cases where these influences are modified. Herein lies the value of abnormalities, of natural experiments, and the results of experimental interference. Possible influences that have at various times been suggested are functional stimuli, the inductive influence of the older pre-formed parts on the developing region, and formative stimuli of unknown nature proceeding from the developing region. The functional stimuli do not come into play at the time of laying down the vascular tracts, though they may have importance in their maintenance later; the inductive influence of the anatomy of older regions is excluded in the first differentiation of the vascular system in an embryo; we are thus led to attach special importance to the detection of the action of formative stimuli proceeding from the young developing primordia. We have further to take external stimuli into account, though these must act by influencing the internal system of relations.

. . . .

I have touched on a number of large questions, any one of which demanded separate treatment. My concern has not, however, been with them individually, but as cognate problems justifying the deliberate

adoption of a causal explanation as the aim of morphological work. I have confined myself to problems bearing on the development and self-construction of the individual, and tried to treat them so as to illustrate the causal attitude and possible lines of attack. Preliminary speculations on the questions considered can at best contain a germ of truth, and must be subsequently adjusted in the light of further facts. I have discussed these questions rather than the smaller modifications in individual development shown in metamorphosis, partly because the latter have of late years been treated from a causal point of view, and partly because I wished to consider questions that immediately affect us as working morphologists.

Did time allow, we should naturally be led to recognize the same change of attitude in biological science toward the problems of the origin of new forms. Questions of bud-variation and mutation are clearly akin to some of those considered, and the whole subject of genetics is a special attempt at a causal explanation of form and structure and the resulting functions. Close cooperation between the morphological analysis of the plant and the genetic analysis attained by the study of hybridization is most desirable. It is especially desirable that both should deal with structure as well as with form, and in the light of individual development.

The causal factors which have determined and guided evolution can be naturally regarded as an extension of the same line of inquiry. The Darwinian theory, and especially the exposition of the principle of natural selection, was the greatest contribution ever made to the causal explanation of the organic world. Strangely enough, it led to a period of morphological work in which the causal aim was almost lost sight of. Why evolution has taken place in certain directions and not in others is a problem to the solution of which causal morphology will contribute. The probability of orthogenesis, both in the animal and vegetable kingdoms, is again coming into prominence, however it is to be explained. When we consider the renewed activity in this field it is well to remember that, just as is the case with causal morphological work, we are picking up a broken thread in the botanical web. Lastly, as if summing up all our difficulties in one, we have the problem of adaptation. In attacking it we must realize that use and purpose have often been assumed rather than proved. We may look to scientific ecological work to help us to estimate the usefulness or the selection value of various characters of the plant. On the other hand, causal morphology may throw light on whether the "adaptation" has not, in some cases at least, arisen before there was a "use" for it. The hopeful sign in the recent study of these greater morphological problems is that the difficulties are being more intensely realized, and that rapid solutions are justly suspect. The more the causal attitude is adopted in ordinary morphological work, the more hope there is of these larger questions being inductively studied rather than argued about.

The causal aim is essentially different from the historical one, but there is no opposition between causal and phyletic morphology. They are rather mutually helpful, for there has been an evolution, not of mature plants, but of specific substances exhibiting development. A deeper insight into the nature of ontogeny is thus bound to be of assistance to phyletic morphology, while the tested results of phyletic work afford most valuable guidance in general causal morphology, though this can not accept any limitation to single lines of descent in its comparisons.

I have tried to bring before you the possibilities of causal morphology partly because the same attention has never been given to it in this country as to other branches of botany, and partly because if morphology be conceived in this broader spirit it need not be said that it has no practical bearing. I should not regard it as a serious disability were the study of purely scientific interest only, but this is not the case. When, if ever, we penetrate into the secrets of organization so far as to be able to modify the organism at will (and genetics has advanced in this direction), the practical possibilities become incalculable.

Probably all of us have reflected on what changes the war may bring to botanical work. It is impossible to forecast this, but I should like to emphasize what my predecessor said in his address last year as to pure science being the root from which applied science must spring. Though results may seem far off, we must not slacken, but redouble our efforts towards the solution of the fundamental problems of the organism. This can be done without any antagonism between pure and applied botany; indeed, there is every advantage in conducting investigations on plants of economic importance. It would be well if every botanist made himself really familiar with some limited portion of applied botany, so as to be able to give useful assistance and advice at need. The stimulus to investigation would amply repay the time required. Even in continuing to devote ourselves to pure botany we can not afford to waste time and energy in purposeless work. It is written in "Alice in Wonderland" that "no wise fish goes anywhere without a porpoise," and this might hang as a text in every research laboratory.

A plant is a very mysterious and wonderful thing, and our business as botanists is to try to understand and explain it as a whole and to avoid being bound by any conventional views of the moment. We have to think of the plant as at once a physico-chemical mechanism and as a living being; to avoid either treating it as something essentially different from non-living matter or forcibly explaining it by the physics and chemistry of to-day. It is an advantage of the study of causal morphology that it requires us to keep the line between these two crudities, a line that may some day lead us to a causal explanation of the developing plant and the beginnings of a single science of botany.

W. H. Lang

University of Manchester

WHICH OF THE PRESENT MEMBERS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE HAVE HELD THE LONGEST CONTINUOUS MEMBERSHIP?

This is a question which often comes up at the meetings and several of the old-time members occasionally claim to be the oldest living member.

Mr. F. S. Hazard, the assistant secretary of the association, in going over the list of members, has drawn up the following statement concerning the members now living:

*Hilgard, Eugene Woldemar, Ph.D., LL.D., University of California, Berkeley, Calif. (11.) 1874. B, C, E.

*Würtele, Rev. Louis Campbell, P. O. Drawer E, Acton Vale, Quebec, Canada. (11.) 1875. E, H.

*Paine, Cyrus Fay, 520 East Avenue, Rochester, N. Y. (12.) 1874. A, B.

*Fairbanks, Rev. Henry, Ph.D., St. Johnsbury, Vt. (14.) 1874. A, B, D.

*Wright, Arthur Williams, Ph.D., Yale University, New Haven, Conn. (14.) 1874. A, B.

*Raymond, Rossiter W., Ph.D., LL.D., 29 West 39th St., New York, N. Y. (15.) 1875. B, C, D, E, I, K.

*Abbe, Cleveland, Ph.D., LL.D., U. S. Weather Bureau, Washington, D. C. (16.) 1874. A, B.

*Beal, William James, Ph.D., Sc.D., 40 Sunset Avenue, Amherst, Mass. (17.) 1880. G.

*Clark, John Emory, 34 South Park Terrace, Long Meadow, Mass. (17.) 1875. A.

*Hinrichs, Gustavus D., M.D., 4106 Shenandoah Avenue, St. Louis, Mo. (17.) 1874. B, C.

*Perkins, George Henry, Ph.D., LL.D., University of Vermont, Burlington, Vt. (17.) 1882. E, H.

*Tuttle, Albert Henry, professor of biology, University of Virginia, Charlottesville, Va. (17.) 1874. F.

*Ward, Richard Halsted, M.D., 53 Fourth St. Troy, N. Y. (17.) 1874. G.

*Bethune, Charles James Stewart, professor of entomology, Ontario Agricultural College, Guelph, Canada. (18.) 1875. F.

*Clarke, Frank Wigglesworth, Sc.D., LL.D., U. S. Geological Survey, Washington, D. C. (18.) 1874. C.

*Dall, William Healey, Sc.D., Smithsonian Institution, Washington, D. C. (18.) 1874. F, G.

*Goodale, George Lincoln, M.D., LL.D., Harvard University, Cambridge, Mass. (18.) 1875. G. (Past president.)

*Morley, Edward Williams, Ph.D., Sc.D., West Hartford, Conn. (18.) 1876. B, C, E. (Past president.)

*Pickering, Edward Charles, Ph.D., Sc.D., LL.D., Astronomical Observatory, Harvard University, Cambridge, Mass. (18.) 1875. A, B. (Past president.)

*Rice, William North, Ph.D., LL.D., Wesleyan University, Middletown, Conn. (18.) 1874. E, F, L.

*Stockwell, John Nelson, Ph.D., 2302 Murray Hill Road, Cleveland, Ohio. (18.) 1875. A, B, C.

*Williams, Henry Shaler, Ph.D., Cornell University, Ithaca, N. Y. (18.) 1882. E.

*Chandler, Charles Frederick, Ph.D., M.D., Sc.D., LL.D., professor of chemistry, Columbia University, New York, N. Y. (19.) 1875. C.

*Cooley, LeRoy Clark, Ph.D., 2 Reservoir Square, Poughkeepsie, N. Y. (19.) 1880. B, C.

*Emerson, Benjamin Kendall, Ph.D., P. O. Box 203, Amherst, Mass. (19.) 1877. E.

*Hale, William Henry, Ph.D., 40 First Place, Brooklyn, N. Y. (19.) 1874. A, B, C, E, F, H, I..

Peck, William Adorno, C.E., 1643 Champa St., Denver, Colo. (19.) D.

Clark, Miss Anna M., 400 West 118th St., New York, N. Y. (20.) H.

*Farlow, William Gilson, Ph.D., M.D., LL.D., professor of cryptogamic botany, Harvard University, Cambridge, Mass. (20.) 1875. G.

*Garman, Samuel, Museum of Comparative Zoology, Harvard University, Cambridge, Mass. (20.) 1874. E, F.

*Smith, Eugene Allen, Ph.D., LL.D., state geologist, University, Alabama. (20.) 1877. C, E.

(The asterisk denotes that the member is a Fellow; the number in parenthesis indicates the meeting at which the member joined the association; the date following is the year when made a Fellow; the letters at the end of line indicate the Sections to which the member or Fellow belongs.)

It is appropriate to mention that the late permanent secretary, Frederic Ward Putnam, emeritus professor of anthropology, Harvard University, Cambridge, Mass., who died only last summer, was, at the time of his death, the oldest living member of the association, having joined at the tenth meeting which was held in Albany in 1856.

L. O. HOWARD,
Permanent Secretary

THE MARINE BIOLOGICAL LABORATORY

THE attendance at the Marine Biological Laboratory, Woods Hole, has been as follows:

	1911	1912	1913	1914	1915
Investigators — total	82	93	122	129	137
Independent:					
Zoology	42	44	58	62	69
Physiology	18	14	17	22	20
Botany	8	10	11	10	6
Under instruction:					
Zoology	12	21	21	31	36
Physiology	2	2	7	1	4
Botany		2	7	3	2
Students — total	65	67	69	89	105
Zoology	26	24	33	43	47
Embryology	20	15	22	21	37
Physiology	6	11	8	10	15
Botany	13	17	7	15	6
Total attendance	147	160	191	218	242
Institutions represented — total		57	80	77	79
By investigators	37	43	50	51	59
By students	31	36	41	47	42
Schools and academies represented					
By investigators	3	2	3	1	3
By students	9	1	6	5	9

The evening lectures during the season were:

July 2, "Experimental Production of Racial Degeneracy by Alcohol Poisoning," by Professor C. R. Stockard.

July 6, "The Seals of the Pribiloff Islands," by Professor G. H. Parker.

July 9, "Some Experimental Studies on the Development of the Membranous Labyrinth in the Tadpole," by Professor G. L. Streeter.

July 13, "Effects of Centrifugal Force on the Structure and Development of the Egg," by Professor E. G. Conklin.

July 16, "The Nature of Intelligent and Purposive Action from a Physiological Point of View," by Professor R. S. Lillie.

July 19, "The Control of Infection as Affected by Variation among Parasitic Microorganisms," by Professor Simon Flexner.

July 24, "Protozoa and the Cancer Problem," by Professor G. N. Calkins.

July 30, "Inheritance of Sex in *Lychnis*," by Professor George Shull.

August 3, "Heredity of Criminality," by Professor C. B. Davenport.

August 6, "The Story of Bubonic Plague," by Dr. Martin Edwards.

August 10, "The Rôle of Adsorption in Nerve Conduction," by Dr. Alfred G. Mayer.

SCIENTIFIC NOTES AND NEWS

At the request of President Wilson the National Academy of Sciences has appointed the following to investigate and report on the control of the Panama slides: President C. R. Van Hise, University of Wisconsin, chairman; General H. L. Abbott, Cambridge, Mass.; Dr. George F. Becker, United States Geological Survey; Professor J. C. Branner, Stanford University; Dr. Whitman Cross, United States Geological Survey; Dr. Arthur L. Day, Carnegie Institution; Dr. J. L. Hayford, Northwestern University; Professor Harry Fielding Reid, Johns Hopkins University; Dr. R. S. Woodward, Carnegie Institution; C. Carpenter, Ithaca, N. Y.; August P. Davis, United States Reclamation Service; John R. Freeman, Providence, R. I.

Professor William B. Scott, of Princeton, and Professor A. A. Michelson, of Chicago, have been appointed representatives from the American Philosophical Society to the Second Pan-American Congress meeting in Washington, December 27 to January 8.

Dr. Robert Barany, of the University of Vienna, who has been awarded the Nobel prize in medicine for his work on the diseases of the ear, is at present a prisoner of war in Siberia, having been serving as a surgeon at Przemysl when it was taken by the Russians.

Dr. R. W. Wood, professor of physics at Johns Hopkins University, has returned to Baltimore from the Mount Wilson Observatory, where he has been engaged in photographing the moon, Saturn and Jupiter by yellow light and ultra violet and infra red rays.

At a recent meeting of the executive committee of the American Museum of Natural History, New York, the new position of research associate was created on the scientific staff of the institution. Dr. C. R. Eastman was appointed research associate in vertebrate paleontology, and Mr. M. C. D. Crawford, research associate in textiles.

Professor Otto Baschin, of Berlin, has received from the Royal Prussian Academy of Sciences the silver Leibnitz medal in recognition of his services to geography.

At the annual meeting of the Royal Faculty of Physicians and Surgeons of Glasgow, Dr. Ebenezer Duncan was elected president, and the retiring president, Dr. John Barlow, a councillor.

Mr. E. D. Merrill, who has been spending several months in Washington, D. C., returns to Manila in December to resume his duties as botanist at the Bureau of Science and professor of botany in the University of the Philippines.

The annual meeting of the Southern Medical Association was held at Dallas, Texas, on November 9, 10 and 11. The principal address was delivered by Dr. Rupert Blue, surgeon-general of the United States Public Health Service, on "Sanitary Preparedness." Other addresses were given by Dr. W. L. Rodman, president of the American Medical Association, and Dr. Isador Dyer, of New Orleans.

On November 23 Dr. R. P. Strong, professor of tropical medicine at Harvard University, gave a public lecture on his experiences as head of the physicians who went to Serbia to combat the epidemic of typhus fever.

The lecture was given for the benefit of the social service department of the Massachusetts General Hospital.

Dr. J. G. Needham, of Cornell University, delivered two addresses at the University of Kansas, in the third week of November: one before the Entomological Club of the University on the "Ecology of Certain Aquatic Larvæ," and the other before the students of the university on the "Common Ground of Poet and Naturalist."

Professor D. W. Johnson, of Columbia University, addressed the Yale chapter of Sigma Xi at New Haven on November 18, on the "Surface Features of Europe as a Factor in the War."

Since Mr. Donald B. Macmillan has not returned from the Arctic in time to present to the members this fall an account of the Crocker Land expedition which he led north in 1913, arrangements have been made to show to members of the museum on the evening of December 9 the motion pictures secured by Sir Douglas Mawson on the Australasian-Antarctic expedition. A brief account of the expedition and a description of the action of the films, will be given by Mr. George H. Sherwood, curator of education at the American Museum of Natural History.

The Swiney lectures on geology are being delivered this year by Dr. J. D. Falconer, the subject being "Ice and the Ice Age." The courses are given at the Victoria and Albert Museum, London.

At the age of eighty-five years Sir Allen William Young, the Arctic explorer, died in London, on November 27.

Professor James McCall, principal of the Glasgow Veterinary College, died on November 1, at the age of eighty-one years.

Lieut. Gordon Sanderson, known for his work on the Archeological Survey of India, was killed in France on October 13.

Mr. Donald Ewen, known for his work in metallurgy, has been killed in the war. *Nature* states that he was serving at the time as a private in the London Scottish Regiment, but an order had been issued for his recall, to take up important work at the National Physical Laboratory.

Dr. Gaston Vasseur, professor of geology in the University of Marseilles, has died at the age of sixty years.

Professor Sklarek, for many years editor of the *Naturwissenschaftliche Rundschau*, died in Berlin, on October 10, at the age of eighty years.

The annual sessions of the Federation of American Societies for Experimental Biology, formed by the Physiological Society, the Biochemical Society, the Pharmacological Society and the Society for Experimental Pathology, will be held at the Harvard Medical School in Boston on December 27, 28 and 29.

The following program has been arranged for the meeting of the Sigma Xi to be held in connection with the meeting of the American Association for the Advancement of Science at Columbus: Tuesday, December 28, at 12 o'clock, meeting of the executive committee at lunch at the Ohio Union. At 4 o'clock at Page Hall, annual convention. At 6:30 at Ohio Union, annual dinner.

In connection with the Congress of Clinical Surgeons, meeting in Washington, November 26–27, an interesting exhibit of books and pictures illustrating the history of surgery has been prepared by Dr. Arnold C. Klebs at the invitation of Colonel C. C. McCulloch, librarian of the Surgeon General's Office, and may now be seen in the library hall of the Army Medical Museum.

Adelphi College, Brooklyn, New York, has just been the recipient of an outfit for instruction in astronomy from a friend whose name is withheld. It consists of a telescope of six and a half inches aperture, with driving clock and twelve inches declination and right ascension circles, a six-prism spectroscope which was made to order by Browning, a small transit by Steger of Kiel, and other accessory apparatus. The telescope was made by Alvan Clark, in 1877, ten years before his death, and is considered an excellent instrument. The apparatus is in perfect condition, having had the best of care by its former owner.

AMONG additions to the American Museum of Natural History is a model showing the increased efficiency of the present hospital service at Panama over that of the French period. This model shows a hospital in the French period in care of a Sister of Mercy. Puddles of water were allowed to gather about the ground, and the legs of the beds were placed in cans of water to prevent ants from crawling up. As we now know, yellow fever and malarial fever mosquitoes bred in such accumulations of stagnant water and helped to keep the hospitals well filled. Screens were not used and the ventilation was not of the best. The companion part of the model shows a French hospital, altered to conform to our most modern ideas and knowledge of the relation of insect and disease. A clean, dry cellar, well-kept grounds, screens, increased ventilation and the care of trained nurses serve to change an insanitary, disease-breeding building into the acme of sanitation.

THE Cornell University Medical College has recently reorganized its surgical service at Bellevue Hospital. At the head of the service there is now one "visiting surgeon in charge" with a continuous service. He has general supervision over the entire work and is responsible only to the college and the hospital for its proper performance. There are two visiting surgeons who also have a continuous service limited to some special subdivision of general surgery. They are thus relieved of all routine work in order to devote their time to the particular work with which they are occupied. Under the visiting surgeon in charge are two associate visiting surgeons. These men are on the full time salaried basis, and each has the care of one half of the service. They have as assistants four juniors who are also surgeons to the out-patient department. The organization now also includes a laboratory of surgical pathology and a laboratory of experimental surgery, each under a full-time salaried man. These laboratories are available to all members of the staff, who there have the privilege of working on their individual problems. The entire staff has been appointed to positions in the department of surgery in the Medical College, and all students take a portion of their surgical ward work under this organization. The essential changes from the former system consist in having one head, continuous service, full-time salaried surgeons and laboratories under the immediate jurisdiction of the surgical service. Following is the staff as at present constituted: John A. Hartwell, M.D., assistant professor of surgery, visiting surgeon in charge; George Woolsey, M.D., professor of clinical surgery, visiting surgeon; John Rogers, M.D., professor of clinical surgery, visiting surgeon; Kenneth Bulkley, M.D., instructor in clinical surgery, associate surgeon; James Worcester, M.D., instructor in clinical surgery, associate surgeon; Fenwick Beekman, M.D., instructor in operative surgery, junior surgeon; Benjamin Vance, M.D., instructor in pathology, surgical pathologist; J. W. McMeans, M.D., assistant in surgery, assistant in experimental surgery.

UNIVERSITY AND EDUCATIONAL NEWS

OBJECTIONS have been filed to the probating of the will of Amos F. Eno who bequeathed a large sum to public purposes and made Columbia University his residuary legatee. It is said that under the will Columbia University would receive $3,000,000 or more.

A BEQUEST of $50,000 has been made to Cornell University by Mrs. Sarah Manning Sage to promote the advancement of medical science by the prosecution of research at Ithaca.

PROFESSOR H. L. BOWMAN, Waynflete professor of mineralogy at Oxford, reports, according to *Nature*, two gifts to his department. (1) Under the will of the late Sir Arthur Church has been bequeathed £100 for the purchase of apparatus and specimens, together with the chemical and mineralogical apparatus and instruments in Sir Arthur's laboratory and his collection of mineral specimens (other than cut gem-stones). (2) A collection of minerals made by the late Dr. Hugo Müller, containing some 2,000 specimens, has been presented by Mrs. Müller.

DR. ERNEST FOX NICHOLS has resigned the presidency of Dartmouth College and will go to Yale University next year to fill a new chair

of physics in the academic department. Dr. Nichols will at the close of the present academic year have served as president of Dartmouth College for seven years, having previously been professor of physics at Colgate, Dartmouth and Columbia. In accepting the resignation the trustees of Dartmouth College write:

It had been our hope that Dartmouth College might long continue to enjoy your leadership. Yet we can but recognize that the sacrifices which you have already made deserve worthier recognition than the demand that you continue them at serious cost to your own well-being. In the chosen field of science to which you are about to return you will carry our sure expectation of great accomplishment and added honors; but more especially you will carry our warm personal affection, the outgrowth of seven years of intimate fellowship in a common cause.

Professor T. W. Galloway, Ph.D., who has occupied the chair of biology at James Millikin University at Decatur, Ill., since the establishment of that institution in 1903, has been appointed professor of zoology at Beloit College, Beloit, Wisconsin. A. A. Tyler, Ph.D. (Columbia, '97), for some years professor of biology in Bellevue College, Omaha, Nebraska, has been appointed to the chair of biology at James Millikin University, to succeed Dr. Galloway.

At Harvard University James Sturgis Pray, of Cambridge, has been elected as Charles Eliot professor of landscape architecture, succeeding Frederick L. Olmsted, resigned and Robert W. Lovett, of Boston, as Brown professor of orthopedic surgery.

DISCUSSION AND CORRESPONDENCE

GENUS AND SUBGENUS

To the Editor of Science: I have read with interest the discussion of the genus in taxonomy which has been running in recent numbers of Science. I am especially interested in Dr. Allen's condemnation as "intolerable" of "the use of both the generic name in the broader sense, and the subgeneric name (in parenthesis) in incidental references." Emphasizing the last three words of the quotation, one may endorse Dr. Allen's condemnation. But I believe the practise of retaining old genera, except in cases in which they express false concepts of relationship, is often a good one, and that newly discerned natural groups of species within the old genus may better be treated as subgenera.

I have recently reviewed the well-known genus *Salpa* and have had to recognize ten subdivisions in order to express the major groups before coming to species distinctions. It seemed a pity to discard the old genus name *Salpa*. I therefore retained this and classed the ten subdivisions as subgenera, though, if one wished to do so, he could thoroughly justify them as genera. The special student of the *Salpidæ* will bear in mind the subgeneric names and very likely will use them in highly special papers, *e. g.*, *Thalia democratica, Ritteria retracta, Apsteinia punctata,* etc. But in general reference all or any of these would be *Salpa*.

We must recognize numerous supra-specific subdivisions of many old genera and these must be named, but let the broader old generic name be the one in use except when one desires to call attention to the diversities emphasized by the subgeneric names. In the latter case, at the risk of Dr. Allen's condemnation, I would use parenthetically the subgeneric name also. This is a bit awkward, but such minutely distinctive terminology is not so frequently needed. Using the broader generic name merely refuses to introduce unnecessary reference to subgeneric classification. When this is germane to the discussion, of course introduce it. But let us not insist on always dragging in the whole subject in all its intricacies when by so doing we merely distract attention from what we are saying.

In ordinary reference to squirrels it is sufficient to call them *Sciurus*, and the fact that this name so used includes "a score or more of natural groups sharply defined geographically and by minor but not unimportant morphological characters" does not present any argument against such terminology, provided we have at our disposal a subsidiary terminology which can be introduced when the distinc-

tions between the lesser natural groups are relevant to the subject under discussion.

It is difficult to see, in the case of *Sciurus*, or any other group, that we are any better off when we have divided all our species into numerous geographical (and other) species, and have called the old species genera, of course changing the names in the process, than we are when we retain the old species, calling their now recognized subdivisions subspecies, races and forms, and treat as subgenera rather than genera newly discerned natural groups of species within the old genus. Of course, an old genus, if shown to be unsound and to express a false concept of relationship, will be abandoned.

There is almost no limit to the niceties of taxonomic analysis that might be introduced by breeding of all animal species. Any classification short of one founded on such complete data is conventional. The practical question is, what convention shall we adopt? The one here advocated retains, in so far as they are valid, old genus and species names, using a subsidiary nomenclature of subgenera, subspecies, etc., for the more intimate distinctions.

There are several advantages in this course. It does not change general conceptions of genus and species to something of a different grade of taxonomic value. It keeps us in touch with the zoology of the past (*i. e.*, that of year before last). It saves immense labor in ascertaining what forms are meant by the unfamiliar names when one is reading outside his special field. It ensures more general understanding by one's readers. It does not limit completeness of taxonomic analysis, which is recorded in the subsidiary nomenclature. It confines to the field of the specialist, who uses the subsidiary nomenclature only when writing for his fellow specialist, most of the confusion which comes from the acceptance and later the rejection of unjustified terminology. It thus saves the general literature of zoology from the introduction of an immense deal of confusion.

MAYNARD M. METCALF

THE ORCHARD LABORATORY,
OBERLIN, OHIO,
October 26, 1915

NOTES ON THE PERMO-CARBONIFEROUS GENUS CRICOTUS COPE

IN Publication No. 207 of the Carnegie Institution of Washington I described and figured an ilium from the Brier Creek Bone Bed of the Wichita Formation in Archer Co., Texas (page 161, pl. 22, figs. 2 and 3). This bone was assigned to the genus *Cricotus* because of the relative abundance of the specimens associated with large numbers of the vertebral and intervertebral centra of that genus. The peculiar form of the ilium, unique and previously unknown from the North American beds, makes it of peculiar value in correlating faunas of widely separated localities. In looking over Fritsch's "Fauna der Gaskohle" I find an almost identical form of this bone described and figured for two genera, *Diplovertebron*[1] and *Macromerion*.[2] Fritsch recognized these elements as ilia but in some figures confuses parts of the bones with the ischia and pubes. It is at once obvious from a comparison of his figures with those published by me that the bones from the two widely separated localities are nearly identical, even to the smallest details. Unfortunately the ischia and pubes of the Bohemian forms were only partly known to Fritsch and he publishes figures of fragments only.

The two Bohemian genera, from the upper Carboniferous, are embolomerous forms and many of the bones figured by Fritsch as associated with the ilia are strikingly like those assigned to *Cricotus* from the Brier Creek Bone Bed, notably the femur and the smaller bones of the limbs. The inter-centra of *Macromerion schwarzenbergii*[3] are indistinguishable from those of *Cricotus*. The teeth also show many resemblances in the two types, especially in the manner of fixation to the jaw and the slightly infolded dentine of the base.

There can remain no doubt that the family Cricotidæ was present in Bohemia and North America at nearly the same time and was represented by closely related genera. This adds

[1] Bd. 11, Taf. 52, Fig. 2 and Taf. 53, Fig. 14.

[2] Bd. 11, Taf. 6, Figs. 1, 2; Taf. 67, Figs. 1, 2; Taf. 69, Fig. 1.

[3] Taf. 66, Figs. 5*a*, *b*, *c*.

materially to the evidence that the deposits in the two regions were cotemporaneous, a fact hitherto suggested only by the common occurrence of the genus *Edaphosaurus* (*Naosaurus*).

It has been shown by me[4] that North America was probably isolated from the Old World in Permo-Carboniferous time, at least for such forms as the Amphibia, and the suggestion arises of the great antiquity of the embolomerous type permitting such a distribution, a suggestion borne out by Moodie's find of an embolomerous form, *Spondylerpeton spinatum*, in the Mazon Creek beds of Illinois.

Further work suggested by the facts here stated is in progress.

E. C. CASE

A SIMPLE METHOD OF INDICATING GEOGRAPHICAL DISTRIBUTION

IN a recent number of SCIENCE a method of showing geographical distribution is suggested.[1] All who have to work with these problems will agree that political boundaries are unsatisfactory in such work, and also that the system of geographic coordinates (parallels and meridians) is often too exact for the information in hand, and, moreover, does not give a very clear idea of the location to most readers. Although there are obvious disadvantages in the use of rectangular areas such as those suggested, it is probable that their advantages are even greater.

A modification of the boundaries suggested seems desirable from the point of view of uniformity among the sciences. After thorough discussion at several international geographic congresses the government surveys have undertaken the preparation of an international map of the world on a scale of 1 to 1,000,000. The quadrangle adopted for this map seems nearly if not quite as well suited for showing distribution as that suggested recently. If this quadrangle can be adopted there will be a single system of areas for the topographic map of the world and for the purpose of stating distribution, and this has the great advantage of simplicity. There is the further advantage that the statement of the location in the new system will show directly what topographic sheets will give the actual physical environment of the species under discussion.

The quadrangle of the international map is 4 degrees of latitude by 6 degrees of longitude; these quadrangles are designated by a system of letters beginning at the equator and numbers beginning at longitude 180°. The surface of the earth is divided into zones bounded by parallels of latitude, each zone is 4 degrees wide and extends around the earth. Zone *A* extends from the equator to latitude 4°, zone *B* from latitude 4° to latitude 8°, and so on; there are separate sets of zones north and south of the equator, that north of the equator designated by the word "north" and that south of the equator by the word "south." There are also north polar and south polar sheets, each circular and 4 degrees in diameter. The quadrangles of each zone are numbered from longitude 180° eastward around the earth. Thus the two sheets of the international map already published for the United States are *Boston*, North K 19 (latitude 40° to 44° N., longitude 72° to 78° W.) and *San Francisco*, North J 10 (latitude 36° to 40° N., longitude 120° to 126° W.).

The only disadvantage of the international map quadrangle, when compared with the "merospheres" suggested by Adams, is their somewhat smaller size. This is slight when compared with the gain in uniformity secured by the use of the quadrangle already adopted for mapping the world. It is to be hoped that any system of dividing the surface of the earth into quadrangles will in the future be based on the international map.

WILLIAM G. REED
OFFICE OF FARM MANAGEMENT,
WASHINGTON, D. C.,
September 22, 1915

NEW JERSEY CETACEA

APROPOS of Mr. Fowler's note in the August 13, 1915, issue of SCIENCE, I wish to add another New Jersey record for the dolphin, *Delphinus delphis*; early in May of this year I found a dead specimen on the beach at Sea

[4] Publication 207, Carnegie Institution.

[1] Adams, J., "A Simple Method of Indicating Geographical Distribution," SCIENCE, N. S., Vol. 42, pp. 366–68, September 17, 1915.

Isle City, in Cape May County. Owing to decomposition the bones were not obtained then, and on later visit to the locality the specimen could not be found.

In addition to the above species I have secured since 1908 the following cetaceans at or near Sea Isle City; these are now in the collections of the Academy of Natural Sciences of Philadelphia: *Globicephala brachyptera* Cope, *Kogia breviceps* DeB., *Mesoplodon densirostris* DeB., and *Tursiops truncatus* Mont.

WM. J. FOX

THE ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA

Note.—Since the above was written one of the fish-pound crews at Sea Isle City brought in on September 25, 1915, seven live specimens of *Delphinus delphis.*

THE FUR SEAL REPORT

TO THE EDITOR OF SCIENCE: At pages 41, 44 and 57 of the fur seal report of Messrs. Osgood, Preble and Parker for 1914, Senate Document No. 980, recently published, occur important statistical tables giving enumerations of the different classes of seals for 1912, 1913 and 1914, conclusions and inferences from which affect vitally the report as a whole. The source of the figures for 1912 and 1913, which could only have been obtained from the field notes and unpublished reports of the writer now in the hands of the commissioner of fisheries at Washington, is not indicated and in the paragraph of general acknowledgment at page 17 credit to former workers is limited to "printed reports."

GEORGE ARCHIBALD CLARK

STANFORD UNIVERSITY, CALIF.,
November 19, 1915

ROGER BACON AND GUNPOWDER

IN his paper "Roger Bacon and Gunpowder" contributed to the "Roger Bacon Commemoration Essays" (edited by A. G. Little, Oxford, 1914), Colonel Hime tries to prove Roger Bacon the inventor of gunpowder by the method employed to prove Francis Bacon the author of Shakespere's plays—a cipher. Since other contributors to the same volume refer favorably to this effort (Mr. A. G. Little, p. 395, calls it an "ingenious explanation" and Mr. Patterson Muir, p. 301, says that "Colonel Hime establishes a large probability" in its favor), it may be well to note some points against it quite apart from the merits of the cipher itself.

In the first place, the cipher is based upon chapters of the "Epistola de secretis operibus naturæ et de nullitate magiæ" not found in the early manuscript of that work and considered doubtful by Charles in his work on Roger Bacon. Indeed, the opening phrases of two chapters, "Transactis annis Arabum sexcentis et duobus," and "Annis Arabum 630 transactis" suggest their source.

Secondly. Roger Bacon openly alludes to gunpowder in 1267 in his "Opus Tertium" as already in common use in children's toy explosives. Therefore Colonel Hime has to date the "De secretis" at 1248, and to hold that Bacon was at that time "driven to employ cryptic methods by fear of the Inquisition" (p. 334), but that by 1267

> circumstances had totally changed in the lapse of years; the composition of gunpowder . . . had been divulged, and the first use made of the deadly mixture was for the amusement of children (p. 321).

But is there any good reason for dating the "De secretis" in 1248? Much of it sounds like a brief popular compilation from Bacon's three works of 1267–8 concocted by some one else later; compare, for instance, the first paragraph of the sixth chapter of the "De secretis" with Duhem, "Un fragment inédit de l'Opus Tertium," pp. 153–4 and Little, "Part of the Opus Tertium," 50–51. The dedication of the "De secretis" to William, Bishop of Paris, who died in 1249, occurs first in the late edition of 1618 and has not been found by Little in any manuscript.

Then the inquisition bug-a-boo is negligible. Has any one ever shown that the inquisition punished a practical invention? It was not for having invented the telescope that Galileo was persecuted. Moreover, Galileo's was an exceptional case, and it can not be shown that in the thirteenth century the church persecuted men of science. Rather, popes and prelates were their patrons.

But even if we admit that Bacon wrote the "De secretis" as we have it in 1248 and was at that time afraid of the Inquisition, the question remains: why in 1267–8, when mentioning the explosive in those works in which he made such desperate efforts to secure the pope as his patron and boasted repeatedly of his own superiority to his contemporaries, did he not claim the credit of the invention which he had set forth in cipher twenty years before? The simple answer is: it was not his invention.

One instance must be added to show how Colonel Hime misinterprets the text of the "De secretis" in his eagerness to smell powder everywhere. He writes (p. 324):

> Now, towards the end of Chap. X., Bacon speaks without disguise of charcoal under the name of the wood from which it is made, and mentions the two trees, hazel and willow, which give the best. He significantly adds that when charcoal is added to proper proportions of certain *other* substances, something noteworthy happens. Since, then, charcoal is one of the subjects of these two chapters, it becomes *all* the more probable that saltpeter forms another.

In a note Hime adds the Latin of the passage in question:

> Si vero partes virgulti coryli aut salicis multarum justa rerum serie apte ordinaveris, unionem naturalem servabunt: et hoc non tradas oblivioni, quia valet ad multa.

Let us note first that these last words do not mean, "something noteworthy happens," but "don't forget this, because it's valuable." Thus the true wording does not in the least suggest an explosion, as Colonel Hime's translation does. Secondly, the words *partes virgulti coryli aut salicis* probably do not denote charcoal but twigs or rods of hazel or willow, as they do in Bacon's account of the experiment performed by magicians with a split hazel rod. It occurs both in the "Opus Maius" (Bridges, II., 219) and "Opus Tertium" (Little, 49–50; Duhem, 153); I quote the latter.

> Unde magici accipiunt virgas coruli et salicum, et dividunt eas secundum longitudinem, et faciunt eas distare secundum quantitatem palmae, et addunt carmina sua, et coniungunt partes divise; sed non propter carmina, sed ex naturali proprietate. (Wherefore magicians take rods of hazel and willow, and divide them lengthwise, and hold them the breadth of a palm apart, and add their charms, and the divided parts *come together*; but not on account of the charms, but from their very natures).

Thirdly, it is probably precisely this hazel-rod experiment to which the writer of the passage quoted by Hime refers. *Multarum justa rerum serie ordinaveris* seems a hurried equivalent for the more specific directions in the passages in the *Opus Maius* and *Opus Tertium*, and this bears out what I have already suggested, that the *De secretis* may be in part at least a brief popular compilation from Bacon's other works. Finally, the phrase *unionem naturalem servabunt* applies better to the bending together in the middle of two halves of a split hazel rod held apart at the ends than it does to a mixture of saltpeter, charcoal and sulphur.

And now what becomes of Colonel Hime's assertion, "Since therefore charcoal is one of the subjects of these two chapters, it becomes all the more probable that saltpeter forms another"? We may alter it to read thus: since charcoal is not a subject of either of these chapters, it becomes all the more improbable that a method of refining saltpeter is disclosed in them in cipher.

Lynn Thorndike
Western Reserve University

SCIENTIFIC BOOKS

A Meteorological Treatise on the Circulation and Radiation in the Atmospheres of the Earth and of the Sun. By Frank H. Bigelow, M.A., L.H.D., Professor of Meteorology in the U. S. Weather Bureau, 1891–1910, and in the Argentine Meteorological Office since 1910. New York, John Wiley and Sons, Inc., 1915. Pp. xi + 431. 78 figures in the text.

This volume is an elaboration of the papers on atmospheric thermodynamics which Professor Bigelow published in the *American Journal of Science* for December, 1912, and March, 1913, with additions on the laws of storms, on solar constant of radiation, on atmospheric

electricity, methods of barometric reduction, the meteorology of the isothermal layer, on the laws of evaporation, and a few other subjects to which the author has paid special attention for many years by methods which are often highly original. The book may be regarded as a summation of its author's labors on meteorological theory, and records not a few notable advances in meteorological procedure, especially in regard to the reduction of observations.

To the author of this treatise we already owe the standard system of barometry now used by the Weather Bureau of the United States, an important concatenation of terrestrial meteorological phenomena and solar changes which is here presented anew in slightly revised form, a considerable modification of Ferrel's equations for atmospheric movement in storms with an application to tornadoes which has given, for the first time, reliable data for these very intense movements of the air, and some interesting and highly original, though perhaps not entirely conclusive speculations in regard to the causes of the several variations in the electric and magnetic elements. The present work records a further advance in measures of the ionization of the atmosphere which enable the author to clear up the discrepancy of about 300 per cent. which has hitherto existed between different methods of measuring the dissipation of electricity in the atmosphere.

The special topic around which all the others cluster is the application of the universally accepted thermodynamic equations to atmospheric phenomena. In order to accomplish this, the author is obliged to make the gas coefficient (R) of the usual thermodynamic equations a variable, instead of a constant. It may seem a little risky thus to throw wide open the doors of theory, and to make this fundamental "constant," so-called (whose value has been accurately determined from laboratory experiments) vary through a wide range, while still retaining the form of the equations whose accuracy rests upon these same laboratory experiments. We may ask whether the equations whose accuracy as mathematics is conceded, will continue to be applicable if their basis is changed. More than one meteorologist has suggested to the reviewer that Bigelow seems to be trying to make the laws of nature conform to his equations, with the implication that success in this attempt is somewhat doubtful. It can not be denied that an element of empiricism enters into the proposed methods. The author points out correctly that the well-known departure of the atmosphere from adiabatic conditions is inevitable as long as heat and motion (of air currents) are imported into any given volume of air. This is self evident; but will the thermodynamic equations stand up under this extra burden when the effects of wind and radiation, together with several other activities not explicitly named in this "Treatise," are included? The author claims that everything checks, but on examination this is found to mean simply that when limited to a narrow round of interlocking operations, the numerical work can be performed consistently. On testing the results by comparison with facts which have not been included in the theory, a few discrepancies and inconsistencies are found. An examination of these in detail would extend this notice far beyond the limits of a review and can not be attempted here.

It should be distinctly understood that Bigelow's fundamental equation starts with the thermodynamic equation which has been founded on the behavior of a definite volume of a gas or vapor enclosed in hypothetically non-conducting and impervious walls, when only the internal circumstances of pressure, density and temperature are changed; but in the adaptation of this equation to the free atmosphere, other terms are added which represent infringement of this condition by external interference, and still the process is called "thermodynamic." While an enlargement of the boundaries of this science is desirable, and while perhaps no better way can be found for extending these boundaries than by attending to the experiments which nature performs for us on a gigantic scale, still it must not be forgotten that by this new departure we have slipped our moorings and are at sea on an unknown ocean of many vague possibilities, where the precision of the old

thermodynamics may not be easy to retain. If this is recognized, then, knowing that meteorology has never been an exact science, there is no reason why this new departure should not be welcomed and thoroughly tested with whatever modifications and improvements may be found necessary; but warning should be given that the terms are now used in a new sense. The present examples go a long way toward supplying such tests. Bigelow's thermodynamics supplements the equally elaborate hydrodynamics of Vilhelm Bjerknes in a much-needed way. As in all other departments of meteorology, however, the application of the principle is more or less handicapped by the imperfection of the record. A single atmospheric sounding is never completely synchronous, and even if it were, the need remains for connecting the single air column with its surroundings. The importance of a study of cross currents at every level, in both velocity and azimuth, has been shown by Sir W. N. Shaw.

The method introduced in the first part of this work (pp. 262–292) for finding the solar constant, assumes that the reduction of high-sun and low-sun observations by the common, but incorrect, hypothesis (that the transmissive power of the atmosphere has no diurnal variation) will give the solar radiation at the 10,000-m. level, but not the radiant value outside the atmosphere; and that an approximately doubled interchange of thermal quantities above the 10,000 m. level (to which the author is led by his thermodynamics) is due to *reflection* of solar rays from the atmosphere at higher levels; whence the value of the solar radiation outside the atmosphere must be doubled. No one doubts that there is extensive reflection of solar rays by the air. The point to be carefully noted is that these rays can not be both reflected and absorbed. Hence, since any rays which are reflected can have no effect whatever on the thermal state of the substances in question from which the reflection proceeds, this hypothesis also is erroneous. The errors made in these two hypotheses have opposite signs, and it is conceivable that the opposite errors very nearly counterbalance each other, but the procedure is wholly empirical, and any approximation to the truth obtained in this way is accidental.

In spite of the foregoing assumption that all losses of solar radiation above the 10,000-meter level are by reflection, the seventh chapter introduces considerations of absorption and transmission of solar rays by the various 1,000-meter layers up to 90 km. Though inconsistent with the preceding hypothesis, this move is in the right direction. Unfortunately, however, both here and in earlier parts of this work, some serious errors occur. An extensive footnote (pp. 278 to 280) contains the following:

"*Transformation Factors.*

$$\frac{\text{kilogram}}{(\text{meter})^2} = \frac{\text{Gr.} \times 10^3}{\text{cm}^2 \times 10^4} = \frac{\text{Gr.}}{\text{cm}^2} \times 10^{-1}.$$

$$\left(\frac{\text{M.K.S.}}{\text{mech. units}}\right) \times \frac{10 \times 60}{41\,851\,000} = \frac{\text{Gr. cal.}}{\text{cm.}^2\ \text{min.}}.$$

$$\text{Factor} = 0.000014336."$$

The true derivation of the conversion factor for radiant energy from M.K.S. mechanical units into C. G. Min. thermal units is of course:

$$\frac{1\ \text{joule}}{\text{m}^2\ \text{sec.}} = \frac{1\ \text{kilogr. cal.}}{4185.1} \times \frac{1}{\text{m}^2\ \text{sec.}},$$

which is equivalent to

$$\frac{10^3\ \text{gram cal.}}{4185.1} \times \frac{60}{10000} = 0.0014337\ (\text{C. G. Min.}).$$

The same error is repeated on page 377. On page 415 the author defends his mistake thus: "Since the Erg and the Joule are units of work they must refer to the unit volume and not to the unit area.

$$\text{Hence Joule}/\textit{volume} = ML^2T^{-2}\cdot L^{-3} = ML^{-1}T^{-2} = 10^3 \times 10^{-2} = 10;$$

$$\text{While Joule}/\textit{area} = ML^2T^{-2}\cdot L^{-2} = MT^{-2} = 10^3 = 1{,}000."$$

It is quite true that, for example, the radiant energy received from the sun in 1 second on 1 cm.^{2} of surface represents the energy previously distributed through a volume of 3×10^{10} cm.^{3}; and that, when absorbed by a pyrheliometer, the temperature-effect is determined by the volume of water (equivalent to that instrument) which is heated. But in

measuring radiant energy by the pyrheliometer, we are dealing with the *transition at a surface* from radiant to thermal energy. What becomes of the thermal energy afterwards—whether it is distributed to a large or a small volume—does not concern us. The idea of volume is already implied in the definition of the calory which is the thermal effect of a heat unit (equivalent to an equal amount of radiant energy) upon unit volume of water.

The consequences of this mistake are momentous. Whole tables of figures covering several pages have been obtained with this erroneous transformation factor. Other insidious errors may be traced to this misconception. For instance, on page 126 we read: "The Kurlbaum coefficient of the Stefan formula for a perfect radiator is taken at 7.68×10^{-11} (C. G. Min. C°) $= 5.32 \times 10^{-6}$ joules per square meter per sec., so that the air radiates at six times the rate of a perfect radiator in the ether." Six times more than perfection is a rather large order.

In transforming the coefficient in the Stefan Law (on p. 279) by a formula with Planck's constants in C.G.S. units, Professor Bigelow has incorrectly divided by the number of ergs in a joule (10^7), obtaining (p. 280): Sigma $= 5.1210 \times 10^{-12}$ in C.G.S. mechanical units, where the exponent should be -5. His value in M.K.S. mechanical units on this page is sigma $= 5.1210 \times 10^{-18}$, which involves an additional error in the logarithmic work. The correct value (after a small change in the adopted basal number), namely, sigma $= 5.510 \times 10^{-8}$ (M.K.S.) is indeed given at the bottom of the page, but it has not been used on page 126, where still a new error appears. Evidently, the author's ideas on this subject are considerably mixed.

On page 370, the energy of solar radiation "used in heating" the atmospheric stratum "above 38,000 meters," is said to be "the true albedo of the earth's atmosphere," which implies that the author has a very obscure idea of what astronomers mean by "albedo." This is surprising, since he has given a correct definition of the word on page 277.

From what precedes, it results that the numerical values of thermal quantities in Tables 84 and 86, which are said to be in "gr. cal./cm.^{2} min." should all be multiplied by 100, in which case the sum of the "atmospheric thermal quantities attributable to solar radiation" would not bear the remotest resemblance to the "solar constant," an assumption which is fundamental to Bigelow's entire argument; nor would the so-called "total atmospheric radiant energy" be "equivalent to the 'solar constant' at the distance of the earth" (p. 385), since, even were the equivalence merely one of ultimate derivation, other factors must be considered, for example, the loss of solar radiation by reflection in passing through the air, which does not enter into the thermodynamic equation, notwithstanding the author's assertion (on p. 262) that the albedo of the earth "can be found indirectly by thermodynamic computations."

The summation of atmospheric thermal quantities from the surface to 35,500 meters is said to "give the amounts measured by the pyrheliometer" (p. 379); but the "free heat" $(Q_1 - Q_0)$ in each 1,000-meter layer, has been stated for unit mass (since the dimensions of heat, work and inner energy are given as $[L^2]$ on page 376, instead of $[ML^2T^{-2}]$, which requires that both M and T shall be unity), and therefore the numerical values should be multiplied by the density of the layer in transforming them to mass measurement. Moreover, $(Q_1 - Q_0)$ is due to a flux of long duration and therefore should be *averaged*, rather than summed, in order to compare it directly with the solar radiation at a given moment. Finally, although neither an average nor a sum of these quantities is exactly equal to the simultaneously exhibited solar radiation, the free heat, though derived from solar radiation, has no immediate connection with the solar radiation at the midday observation to which $\Sigma(Q_1 - Q_0)$ is incorrectly equated, for it continues by night as well as by day and represents the accumulated result of many days of sunshine, as the writer of this notice has shown in a paper "On the Solar Constant."[1]

[1] *American Journal of Science*, Vol. XXXIX., p. 201, February, 1915.

What the thermodynamic computations do show, however, is that the solar effect on the atmosphere above 35,500 m. is nearly as great as that on the lower layers; and this is a fact of very great importance.

The terms "absorption" and "transmission," as applied to the derivation of atmospheric free heat from the sun's rays on page 377, have apparently been transposed, but are correctly applied as regards terrestrial radiation. This follows because Q is the free heat "transmitted" in a way within the layer, but it is obtained by *absorption* of radiation and is proportional to such absorption, other things being equal.

The atmospheric heat on which depends the internal radiation of the atmosphere J_a, given for each 1,000 meters, is equal to the change in its radiant potential ΔK, and is due to absorbed terrestrial radiation. The curve of the change of density with the altitude agrees with that of the J_a function, showing that the expansile force of the air, or that force which gives its adiabatic expansion, is wholly governed by the mechanism of internal radiation between the air molecules. J_a is largest at the ground surface and progressively diminishes to the outer limit of the atmosphere. The free heat (Q), on the other hand, is distinct from J_a and is wholly devoted to expanding the air above the adiabatic rate. While the summations of the two from the surface to about 31 km. are very nearly equal, their distribution is quite different. Q is very small in the lowest layers and increases upward, but with wide fluctuations. In a general way Q follows the fortunes of the incoming solar rays, and while it may not be wholly dependent on their absorption, it appears to be very nearly so. There is no evidence that the curve of density agrees with the solar radiation at every level, as is asserted in Chapter VII.

If the air radiated like a black body, the radiation J_e of any layer could be computed from the temperature by Stefan's Law. Summed, layer by layer, for the air column up to 50 km., $\Sigma(J_{e-1} - J_{e-0}) = -381.81$, while $\Sigma(J_{a-1} - J_{a-0}) = -136.75$, or the air radiation is about one third that of a black body. The figures, as thus stated, denote a thermal transference of so many gram calories per minute within a volume of five million cubic centimeters, and are derived from Bigelow's computation after correcting for the erroneous transformation factor; but they lend no support to his curious conclusion that air radiates six times better than the black body.

The pyrheliometric method for finding the solar constant which is described in Chapter V., is further extended and modified in Chapter VII., pages 388 to 394. This method is finally admitted to be discredited by experience, though its author does not recognize why this is so. A new and entirely different method of discussing pyrheliometric data is then developed (pp. 394 to 401) which, though empirical, appears to eliminate the influence of water vapor and altitude in the general means very well, making it possible to compare winter observations with summer, and also to determine a station correction to sea level. In this method the erroneous data derived from incorrectly interpreted thermodynamics are abandoned. The extrapolation of the resulting curve (A, Fig. 76) gives solar radiation = 3.22 at the height for which the writer's reduction of Violle's high-level observation gave 2.86 gram cal./cm.^{2} min.; and thus it appears probable that the value which Bigelow adopts for the solar constant (3.95) should be reduced to 3.6 gram cal./cm.^{2} min. A similar result follows from the writer's interpretation of the thermodynamic argument.

The formula for the mass of aqueous vapor in the upper air (pp. 342 and 373) is both complicated and erroneous. It gives a value about three times too large at 10,000 meters, ten times too large at about 24,000 meters, and increasingly greater at still higher altitudes.

The author's faith in the virtues of a formula is seen in his publication of some columns of figures which make such well-recognized constants as the mass of a hydrogen atom and the charge on an electron, variable. There are a few minor mistakes, such as the conversion of the charge on an electron through the use of an erroneous dimensional formula, but these will be readily recognized.

The work under review is one of extremes. It ascends to heights of excellence and brilliant achievement, and then breaks down, where one would least expect it, in errors and fallacies which seem inexcusable in one so gifted. It is greatly to be regretted that a book involving so much original work, and containing so much that is really valuable, should be marred by blemishes which prevent it from being regarded as an authority. Nevertheless, if the judicious reader will pardon these blemishes, the larger part of this treatise constitutes a monumental work of great erudition, and of elaborate and industrious research.

FRANK W. VERY

The International Rules of Zoological Nomenclature, with Appendix and Summaries of Opinions No. 1 to No. 56. T. O. SMALLWOOD, 3216 N St., Washington, D. C., September, 1915. 4to. 28 pp.

The ninth International Congress of Zoology met at Monaco, March, 1913. The full report was issued by the Imprimerie Oberthur, Rennes, France, 1914. Owing to the disturbances in Europe this report is practically inaccessible to students, and no separate copies of the rules in English appear to be available, nor does any provision seem to have been made for the republication of the rules separately. Hence the publisher of this pamphlet, with the approval of the secretary of the International Commission and the careful supervision of some of the American members, has provided what may be regarded as a trustworthy edition which may be obtained as above indicated.

A partial reprint of the rules without the opinions has been issued in French by M. Maurice Cossmann in the *Revue critique de Paléozoologie* for July and August, 1914, and in this connection a word of caution seems to be required. On page 14 of the separate copy of this rendition of the rules we read as follows under the following caption:

Autres Décisions du Congrès se Rapportant à la Nomenclature

A. Des exceptions à la loi de priorité pourront être admises:

1°. Quand un nom de Genre ou d'espèce devrait être transporté à un autre Genre ou à une autre espèce existants;

2°. Quand un nom a été employé pour un Genre pendant 50 ans, jusqu'à 1890, dans les travaux scientifiques, tels que monographies, catalogues scientifiques, etc.;

3°. Quand le nom le plus ancien, conformément à la loi de priorité, n'a pas été admis pendant 20 ans dans la systématique scientifique.

Note.—Chaque exception doit être soumise à la Commission internationale de Nomenclature qui examine chaque cas et le soumettra au prochain congrès international.

As the title of the pamphlet reads "Règles internationales . . . Adoptées par les Congrès," etc., it would seem that the reader might readily suppose that the paragraphs quoted from M. Cossmann's reprint (but not appearing in the English version) had been affirmatively decided by the congress. This, however, is not the case. Paragraphs *A*2 and *A*3 were submitted, it is true, but were definitely rejected, though no indication of this appears in the French reprint. Paragraphs *A* and *A*1 are qualified by the note under paragraph *A*3, each case to be submitted to the commission and decided on its merits.

WM. H. DALL

SPECIAL ARTICLES

THE LIGHT-SENSIBILITY OF COPPER-OXIDE

THE fact that selenium changes its electrical conductivity under the influence of light was discovered by May in 1873. Since that time the property of light-sensibility has been looked for in many substances and it has been found that sulphur, shellac, paraffin, anthracene and several other substances possess this property to a slight extent. The most noteworthy addition to the list was made by Jaeger who discovered the light-sensibility of stibnite (native Sb_2S_3) in 1907. Since a careful study of the behavior of these substances is bound, ultimately, to shed light on the mechanism of metallic conduction, it seemed worth while to continue the search for other substances which show marked light-sensitiveness. Recently the

writer found that copper-oxide (Cu_2O, presumably) shows the effect quite unmistakably.

Without going into details here as to the mode of production of copper-oxide cells or bridges, it may be stated that copper-oxide has a much lower specific resistance than either selenium or stibnite and is much the more transparent toward red light (layers having a thickness of more than 1 mm. are still slightly translucent). The fundamental facts which have been established for this new light-sensitive substance are:

1. The conduction is electronic and not electrolytic.

2. The increase in conductivity, occasioned by light, is distinctly different from that produced by a heating effect.

3. The conductivity increases with the applied voltage, *i. e.,* Ohm's law is not obeyed (voltage effect).

4. The region of increased conductivity spreads slightly to portions of the material not illuminated (transmitted effect).

5. The region of highest sensibility lies in the ultra-violet near $\lambda = 2800$ A. U.

6. Cooling in liquid air increases the percentage change in conductivity and displaces the sensibility maximum in the red toward shorter wave-lengths.

7. The relation between the radiant energy absorbed (E) and the resultant change in conductivity (C) is very approximately of the form $C = KE^\beta$ where K is a constant and β lies near 0.5.

While the percentage change in conductivity upon illumination is much less than that of selenium and stibnite, the comparatively high conductivity of copper-oxide makes the absolute increase quite large. The best cell which the writer has thus far constructed has a resistance of 15,200 ohms at 17° C. for 1 volt. The change in conductivity occasioned by the light from a 40-watt tungsten lamp at 20 cm. is about 15 per cent. The area exposed to radiation is about 12 mm.^{2} If this cell be connected to a 2-volt cell and a galvanometer (forming part of a simple potentiometer) a sensitive device for detecting radiant energy is produced. Exposing the cell to daylight in a moderately lighted room throws the galvanometer spot of light violently off the scale. Monochromatic radiations which are quite too feeble to affect a sensitive radio-micrometer, bring about large deflections when allowed to fall on the copper-oxide cell. If the cell be connected to a telephone receiver and battery and if an intermittent light beam of definite frequency be allowed to fall on the cell, a clear, musical note is heard.

The preceding discussion is to be looked upon as being of a preliminary nature. A systematic search for light-sensibility is being undertaken and a complete account of the work will appear later.

A. H. Pfund

Johns Hopkins University,
November, 1915

RADIOACTIVITY OF UNDERGROUND WATERS IN PROVIDENCE AND THE VICINITY

Some idea of the distribution of radium salts near the surface of the earth may be obtained from a study of the relative amounts of radium emanation dissolved in underground waters. Within the last ten years a number of the better known springs and wells in America, Europe and Japan have been examined for emanation content. Some of the activities obtained have been tabulated by Schlunt and Moore[1] also by Dole.[2]

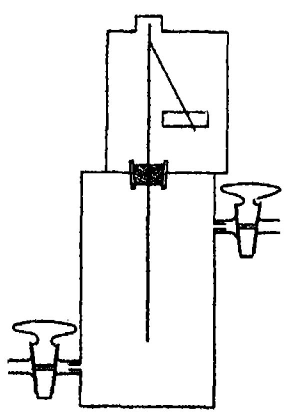


Fig. 1.

[1] U. S. Geological Survey Bulletin 395, 1909.

[2] U. S. Geological Survey, "Mineral Resources of the U. S., 1913," Part II., pp. 393–440.

The most active source thus far recorded was found in mine water at Joachimsthal, Bohemia, and contained per liter an amount of emanation equivalent to that in equilibrium with 700×10^{-10} gram radium.

Fig. 1 shows the type of electroscope used in the present experiments. The gold leaf was mounted on a brass rod passing through a sulphur plug into the ionization chamber. The leaf was used at a fairly high sensibility. Since it was not convenient to use a guard ring, the natural leak of the instrument was large, varying from .25 to .40 divisions per minute on different days. No suitable constant source of potential was available and the leaf was charged with an ebonite rod by removing the metal cap at the top. The ionization chamber was gas tight and was of approximately 725 c.c. capacity.

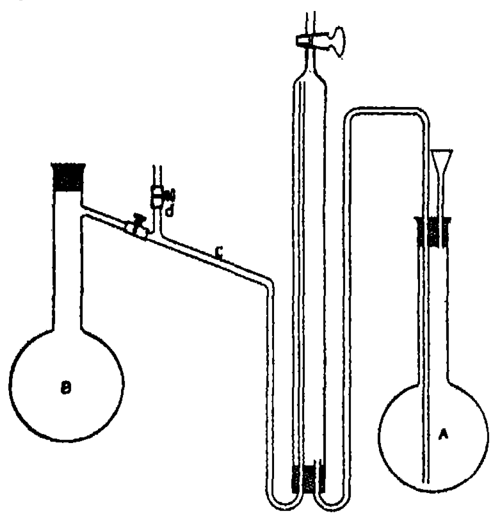


FIG. 2.

Samples of water to be tested were collected in suitable boiling flasks at different localities. The contained emanation was removed by boiling and allowed to cool. The ionization chamber was then partially exhausted, and the mixture of air and emanation allowed to flow slowly into it through a drying tube of calcium chloride with end plugs of cotton wool. The rate of motion of the gold leaf in divisions per minute after three hours was used in comparing the activities of different samples. All readings were corrected for the natural leak of the instrument and for the decay of the emanation itself during the time elapsing between collection and examination. After three hours the emanation was pumped off by means of a foot bellows through a long pipe into the open air far outside the laboratory. The ionization then decayed with the half value period of active deposit.

A diagram of the apparatus used for boiling out the emanation which is but a slight modification of that described by Makower and Geiger[3] is shown in Fig. 2. The burette was filled with water previously boiled in the flask *A*. The water under investigation in flask *B* was boiled from ten to fifteen minutes. Emanation still remaining in the connecting tube *c* after the burette had been emptied was carried over into it by air let in through the side tube *d*. 920 c.c. of water was collected for each test.

Standardization of the Readings of the Electroscope

In order to standardize the readings of the electroscope 10 c.c. of a standard solution containing 1.57×10^{-5} mg. radium was diluted to 250 c.c., and 60 c.c. of this solution boiled thoroughly and allowed to grow emanation for 31 days. This emanation, the equivalent to that in equilibrium with 3.77×10^{-9} gram radium, was introduced into the electroscope. The ionization after three hours was 57.11 divisions per minute.

The results obtained from a number of sources are given in the following table:

Column 5 in the above table records the amounts of radium emanation found in the different sources. These values are comparatively large. The maximum activity found in spring water by Shrader[4] near Williamstown, Mass., was 2.12×10^{-10} gram radium. The most active sources found during this investigation were in Arlington, R. I. Both the springs examined flowed out of Fenner's Ledge. This contains deposits of graphite mixed with a low-grade soft coal. The geological

[3] "Practical Measurements in Radioactivity," Longmans, 1912, p. 114.

[4] *Physical Review*, May, 1914, pp. 339–345.

Source	Locality	Approx. Cap. Liters per Min.	Corrected Div. per Min. per Liter.	Equivalent in Radium 10^{-12} Gram	Remarks.
Spring	Arlington, R.I.	10	87.78	57.93	Graphite mine.
Spring	Arlington, R. I.	6	70.80	46.71	Nr. car barn.
Spring	Nr. Wilbur Ave.	3	17.74	11.70	On Woonsocket car line.
Spring	Girard's Hatchery	30	16.98	11.19	Mineral Spring Ave.
Spring	Quinsnicket Park	5	15.65	10.33	Called Cool Spring.
Spring	Girard's office	.....	5.85	3.86	150-gal. tank.
Well	Nr. Bristol, R.I.	.....	4.21	2.78	60 ft. deep.
Spring	Smithfield Ave.	1	3.39	2.24	Nr. reservoir.
Spring	Johnson, R. I.	.....	3.34	2.20	Ochee.
Spring	E. Providence	2	1.78	1.18	On Lion Farm.
Well	College pump	.....	1.10	.73	On Campus.
Well	In heating plant	.....	1.03	.68	On Campus (unused).
Tap water	Eng. Lab.	.....	.05	.03	From city reservoir.

formation is such that the water comes in all probability from a considerable depth. Graphite is now being mined near the surface. Several samples of this graphite were powdered and tested qualitatively in an α ray electroscope. Only slight traces of radioactive content could be found.

I am indebted to Professor B. B. Boltwood, of Yale University, for the standard solution used in calibrating the electroscope.

Brown University, P. B. Perkins
June 14, 1915

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 489th meeting of the society, held October 19, 1915, Dr. D. S. Lamb read a paper on "The Medicine and Surgery of the Ancient Peruvians." They used Peruvian bark for fevers. It is doubted whether syphilis, leprosy and tuberculosis occurred among them, although some infer that skin tuberculosis caused the mutilations represented on their pottery. Three skin diseases peculiar to the ancient Peruvians were the *mirunta*, the *verrugas* and the *uta*. Smallpox, measles, scarlet fever and yellow fever were introduced by the whites. Goiter prevailed; also the *tabardillo*. The heads of their infants were deformed. They let blood and treated dislocations, wounds and fractures, and trephined the skull. Dr. E. L. Morgan and others who discussed the paper agreed with the speaker in thinking that trephining had probably begun with the idea of getting rid of the evil spirit but was continued for its observed curative value. The idea of ridding the patient of an evil spirit was common to all primitive peoples. In the Iroquois language, said Mr. J. N. B Hewitt, the expression used in case of sickness is, "It is biting me." Dr. C. L. G. Anderson held that the megalithic people who preceded the Incas also knew much about medicinal herbs. They made infusions, powders and ointments of them. Sulphur, salty earths and hot springs were used as cures of rheumatism and skin diseases. Sarsaparilla, coca and quina were local drugs used.

Daniel Folkmar,
Secretary

NEW ORLEANS ACADEMY OF SCIENCES

The regular meeting of the academy was held in Tulane University on Tuesday, October 18. Dr. Gustave Mann presided. The paper of the evening was by Professor O. M. Rosenwall on "Some Methods of Offense and Defense among Insects."

The paper outlined the orders of insects which were to be touched upon and the specific insects which were to be referred to. As far as possible, insects found in the state of Louisiana were used as examples.

Among all the methods mentioned, those which were "active in defense," made up the material for the greater part of the paper, and these were mainly the "repugnatorial glands." This means of defense was possessed by some species of nearly all the important orders, and mainly in Coleoptera, Hemiptera and Orthoptera.

In many of the insects the appendages are adapted as means of defense, *e. g.*, mandibles and front-legs. At this point, the "praying mantis" was discussed, being one of the common insects of this region.

Then followed the use of "stings" in connection with "poison-glands," and the following subjects were discussed briefly: "Poisonous Saliva," "The Repellant Fluid of Several Species of Coleoptera," "Phosphorescence" and "Protective Attitudes"; the paper closing with "The Means of Defense among Insect Larvæ."

An interesting discussion among members took place after the reading of the paper, and examples of the insects discussed were on exhibition. The academy then adjourned.

R. S. Cocks,
Secretary

SCIENCE

FRIDAY, DECEMBER 10, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AERIAL TRANSMISSION PROBLEMS[1]

THE title of my address suggests that I propose to discuss the problems connected with wireless telegraphy and telephony. It should be observed, however, that ordinary telegraphy and telephony and electrical transmission of large amounts of power is aerial transmission and faces some of the problems which confront us to-day in wireless transmission. But, of course, the problems of aerial transmission in their relation to wireless telegraphy and telephony present their most interesting aspect and I shall, therefore, devote most of my time this evening to this particular aspect, of the problem of aerial transmission.

Permit me now to differentiate, briefly, wireless transmission from ordinary electrical transmission.

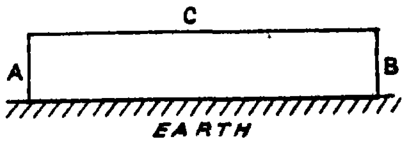


FIG. 1.

Fig. 1 represents the simplest form of ordinary electrical transmission. A wire, *ACB*, is connected to the earth at each end. A generator station at *A* sends electrical energy to receiving apparatus stationed at *B*. The motion of electricity started at *A* is transmitted along the wire *C* to the station *B* and then is completed through the conducting ground between *B* and *A*.

[1] An address delivered before the National Academy of Science, at its meeting in New York, November 15, 1915.

Fig. 2 represents the simplest form of wireless transmission. An electrical gen-

Fig. 2.

erator at A sends through a vertical wire electrical energy to a vertical wire at station B. There is motion of electricity between A and B, but only through the earth. The second case is similar to the first except that in the second case there is no wire C, connecting station A to station B; hence, on account of the absence of the connecting wire C, we call the second method of transmission a "wireless" method. This second method is particularly important when it is impossible to employ a connecting wire between the two stations, as, for instance, between two ships at sea, or between a ship and the shore.

This more or less insignificant difference in the structures, by means of which we transmit, necessitates, however, the employment of almost radically different electrical actions in order to transmit energy from A to B. Whereas in the first case we can transmit from A to B any reasonable amount of energy by a constant or a slowly varying motion of electricity, we have to adopt in the second case a very rapidly oscil-

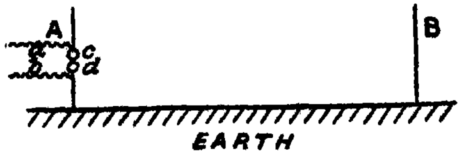


Fig. 3.

lating motion of electricity. The simplest and historically the oldest method of producing a rapidly oscillating motion of electricity was obtained as follows: The vertical wire at the transmitting station A, called the antenna, has an air gap cd and the two parts of the antenna, the upper part which is insulated, and the lower part which is connected to the earth, are connected by means of wires a and b to a very high electrical tension such as is employed in our automobiles for ignition or in the production of X-rays by means of the X-ray tubes and the induction coil. This high electrical tension forces one kind of electricity into the upper part of the antenna and the opposite kind into the lower part of the antenna which is connected to the earth. The two parts of the antenna form the two conducting coatings of a Leyden jar; the surrounding atmosphere, of which the air gap cd is a part, separates the two coatings. When the electrical tension is very high it breaks through the air space cd, that is, a spark jumps between the two metal balls cd and forms there a conducting path, that is an easy path for the motion of the electricities which are separated, one crowded into the upper part of the antenna, and the other into the lower part and the earth. These two separated electricities which attract each other will rush toward each other as soon as the passage through the air gap cd has been established, and they will move as fast as the laws of motion of electricities command them to do. Now these laws demand that this motion be an oscillatory one. This oscillatory motion of electricity during a discharge of a Leyden jar was discovered by our great Joseph Henry in 1840 when he was professor of physics at Princeton College, and the laws of motion were first formulated in 1855 by the famous William Thomson, who died a few years ago as Lord Kelvin. The oscillatory motion of electricity and the laws governing it can be best illustrated by the following simple mechanical analogy. A stiff steel tongue ab which is fastened at its lower end a to a table is displaced by the tension of a string d from

its position of equilibrium. Increase the tension until the string d breaks when the displaced steel tongue is released; it will then return to its normal position after per-

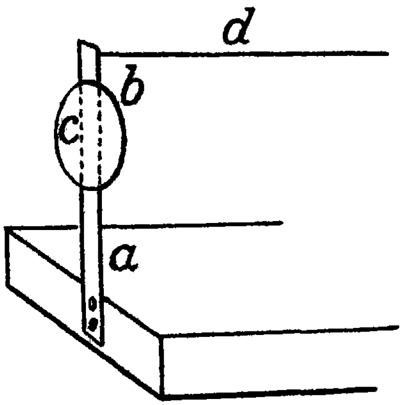


FIG. 4.

forming a few oscillatory movements. The analogy between the motion of the steel tongue and the motion of electricity referred to above is quite complete and to make it even more complete I attach a cardboard disc C which by transferring a considerable part of the motion of the tongue to the surrounding air will accelerate the dying out of the oscillatory motion of the tongue by the transference of the energy of the vibrating cardboard to the surrounding air. Here is a tuning fork which I pluck with my fingers instead of employing the tension of the string, or which is still better, I give it a gentle impulse with a soft hammer. After each impulse the fork oscillates, imparting some of its motion to the surrounding air, and the vibratory motion of the air propagated in all directions impinges upon your auditory organs and thereby produces in your consciousness the sensation of sound. In the same manner the vibratory motion of electricity in the antenna is communicated to the electricity near the surface of the earth, causing it to move in the same vibratory fashion; these vibrations spread out in all directions and travel along the surface with the velocity of light, that is, about 180,000 miles a second. This propagation along the surface of the earth of the oscillatory motion of electricity is called electrical wave motion, just as the propagation of the vibratory motion of the tuning fork through the air is called wave motion. Just as the sound waves produced by the vibration of the tuning fork or by my vocal cords spread out in every direction, getting feebler as they progress further and further, but producing a sensation of sound in every healthy ear which they find anywhere, so the propagation of the vibratory motion of electricity along the surface of the earth spreads out in every direction, getting feebler as it advances further from the sending antenna, but producing a definite effect in every upright wire like B in Fig. 3, which effect can be detected very clearly by a suitable electrical instrument connected with the wire B. This, briefly stated, is wireless transmission of electrical signals.

We often hear that wireless transmission is only a practical application of electrical waves discovered by a German, the late Professor Hertz; that it is an art which formed its first roots in German soil, whereas in reality it is a particular case of the oscillatory motion of electricity discovered by Joseph Henry and the laws of which were formulated by Kelvin. It is true that Hertz employed these oscillations more skilfully than anybody else ever did prior to his time, and thereby succeeded improving experimentally the complete validity of the physical foundation of the great electromagnetic theory which was conceived and formulated by Clerk Maxwell, the great Scotch physicist. It is also true that Guglielmo Marconi in 1895, when a mere youth of twenty-one, fascinated by the beauty of the Hertzian experiments, was busy with Hertzian electrical oscillators

when he suddenly discovered that an oscillator connected to the earth, as described in Fig. 3, was much more efficient than any other form of oscillator in propagating an oscillatory motion of electricity from any given point of the earth to any other point. That discovery gave birth to wireless telegraphy. But, nevertheless, this discovery could have been made prior to the time of Hertz by any one who understood the work of Henry and of Kelvin and interested himself in the study of electrical oscillators of various types. I think that Marconi discovered wireless telegraphy; he did not invent it. The inventing period in this new art started after the discovery was made and when various problems connected with the development of this new art presented themselves.

The earliest attempts to advance the new art were in the direction of increasing the distance which could be bridged over by this new method of electrical transmission. As early as 1902 Marconi attempted the bold experiment of sending wireless signals across the Atlantic. These attempts resulted at first in an enormous increase in the height of the antennæ and the power of the generators which create the electrical oscillations at the sending station. The wireless structures employed as sending antennæ were anything but wireless, and the generating stations which fed them were veritable thunder and lightning factories. The roar of the thundering sparks transmitting signals between England and Newfoundland would terrify the whole neighborhood of the transmitting station, and yet at the receiving station there would be only very faint clicks in a very sensitive telephone held over the anxious ear of a skilled operator. Physicists with artistic temperament, that is, with a sense of right proportions, always felt that these thunder and lightning factories had no place in wireless transmission. Three years ago I suggested that if a little more science were put into the General Electric Company we would soon have a noiseless generator which would replace those thundering spark-gaps. Well, the General Electric Company has put a little more science into Schenectady and we have today a generator which can supply any reasonable amount of electrical power in the form of electrical oscillations of very high frequency, say, twenty thousand to two hundred thousand vibrations per second, and it supplies it smoothly and silently. The horrible racket of thunder and lightning has disappeared for good from the wireless transmitting stations.

In the meantime another great and wonderful advance has reached the wireless transmitting station. This advance is so far reaching in its purely scientific aspect that I feel constrained to devote to it a few brief moments. Consider a generator of electrical oscillations sending out from a wireless station at A (Fig. 5) a continuous train of electrical waves ab of high frequency or pitch, say fifty thousand periods per second. A person with a telephone receiver at the receiving station B would hear nothing, because the pitch of the re-

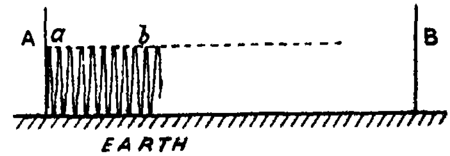


FIG. 5.

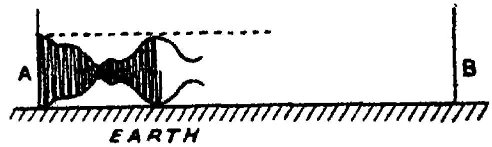


FIG. 6.

ceived waves is too high. Suppose now that by some means the generator is made to vary the amplitude of the outgoing

waves as indicated by the thick wavy curve in Fig. 6, and suppose that these variations follow the law of variation of sound waves in articulate speech, then the man holding a telephone to his ear at the receiving station B, equipped with a suitable apparatus, will hear articulate speech. This idea is not new; I disclosed it in 1902 to Professor Henry Perkins, of Trinity College, Hartford, and I consider the idea as obvious. But what I do not consider as obvious is the manner in which a huge generator of electrical power can be made to vary the power which it delivers in that most complicated way which we human beings practise when we vibrate our vocal cords in order to produce articulate speech. When the Western Electric Company and the American Telephone and Telegraph Company transmitted articulate speech between Arlington and Honolulu they actually controlled by the human voice the operation of a huge electrical generator generating many horse power, and it is plain that the same method can be easily extended so as to control any amount of power by the human voice. It is, indeed, a great achievement. It may be claimed that the achievement is nothing startlingly new, for do we not know that with a tiny spark we may start a huge explosion and do we not see every day that the chauffeur by minute twists of his hand or foot can regulate the power of the gas engine in our automobiles? Yes, I admit that there is a resemblance, but the resemblance is a very coarse one. When you find a chauffeur who can regulate the movement of his car in such a way that it will vibrate in accordance with the vibrations of articulate speech, then that chauffeur will have accomplished the same thing which the operator at the Arlington Station did when by the controlling action of his voice he made his huge generator speak the words which were heard at Honolulu, five thousand miles away. And yet the achievement is perhaps not quite as new as it might appear. When a Paderewsky with Beethoven's Sonata in his head makes Beethoven's ideas control the strenuous movements of his body which agitate the strings of the piano, then I see something which the operator at Arlington might have been unconsciously copying. I throw this out as a suggestion to the biologists, the physiologists, and the neurologists, who are not always aware of what is going on in other departments of physical science, just as we physicists are often totally ignorant of the great researches in biology, physiology and neurology.

Let us now turn our attention to the electrical waves which carried that articulate message from Arlington to Honolulu and examine their condition when they arrived at Honolulu. These waves were so feeble that no electrical instrument ever invented by man could, unaided, ever detect their presence. This brings me to a point which I discussed before this academy just four years ago. I told you then that I had discovered an electrical machine which stimulated by a feeble electrical wave of high frequency would reproduce that wave magnified to any extent. I believe that in that discussion was the first mention of the electrical "amplifiers" which play a most important part to-day in wireless transmission. It is far from me to claim the whole credit for the work which has been done in this direction; on the contrary, most of the credit for developing the idea of electrical amplifiers of to-day and of giving them a thoroughly fool-proof form belongs to the research laboratory of the General Electric Company and of the American Telephone and Telegraph Company, and I cheerfully congratulate them upon the wonderful achievement.

Now what is an amplifier of these high frequency electrical waves? Broadly speak-

ing, it is a local source of electrical energy which stimulated by an electrical wave no matter how feeble will give a perfect reproduction of that wave magnified to any extent that may be desirable. When the electrical wave conveying speech from Arlington to Honolulu arrived at Honolulu it was perfectly exhausted and so feeble that its action could not produce any perceptible direct effect upon any instrument ever constructed by man. The electrical amplifier, that is, the local electrical generator, then threw in its wonderful work. Stimulated by the feeble wave it reproduced it in a tremendously magnified form without in any way modifying its character. The man at Honolulu, with the aid of the local amplifier, not only heard the voice of Arlington, five thousand miles away, but by the characteristics of the articulation he recognized the speaker: so perfect was the reproduction by the amplifier! In fact, we may say that the electrical amplifier at Honolulu stimulated by the waves coming from Arlington created over again at Honolulu the articulate speech uttered at Arlington. Permit me now to offer a suggestion which has occurred to me often, and which, I think, may be of some interest to the biologist and the neurologist. We all know that the eye, the ear, and other organs which are the instruments of our perceptions are extremely sensitive. For instance, the amount of energy conveyed to the eye by light, which is just visible, is almost incredibly small. The question arises now, does that energy produce in us directly the sensation of light or does it serve as a stimulus, only, for a local source of energy, the sensatory organs, which amplify it and reproduce it somewhat in the manner as the electrical amplifier reproduces, on a very much magnified scale, the faint traces of a wireless wave? The structure of the nervous system seems to support this bit of speculation and I trust that you will not be too severe with me for indulging in it.

From this very rough sketch which I have just drawn for you describing the present state of wireless transmission it appears that there are at present no obstacles in the way of extending the distance of wireless communication to any point on the earth. And yet there are, and they are of the most formidable character. These obstacles are due to the interference produced by electrical waves which are passing through the terrestrial atmosphere continuously. One may say that electrical waves are just as numerous in the atmosphere as water waves are on the surface of the sea. They are of the same general character and probably due to the same causes as the electrical waves which interfere with our telephone and telegraph lines and with power transmission wires during a thunderstorm. They are, in fact, the electrical tremors of minute thunderstorms or of powerful but very distant thunderstorms. We were not aware of their presence until we attempted to magnify the minute electrical wave coming from a very distant signalling station. An engineer of the American Telephone and Telegraph Company who was on the Pacific Coast and watched for the famous telephone message from Arlington reports that at times it was drowned completely in a roar of musketry. This roar was due to the action of the electrical waves produced by the incessant electrical discharges in the atmosphere. The wireless telegraph engineer calls these discharges the "static" and he hates them, because they interfere with his business, but the physicist and particularly the meteorologist will hail their appearance with delight, because they offer him a new and most unexpected aid for the study of the activities in the terrestrial atmosphere.

All attempts up to the present time which

the so-called "practical" wireless engineer has made in the direction of overcoming the interference of the "static" consisted in increasing continually the power applied at the signalling station so as to make the signals at their arrival at the receiving station stronger than the signals made there by the static. These attempts failed, as they should. The static is an act of God and his acts can not be neutralized by brute force. The machinery of nature will not interfere with the machinery constructed by man if man puts a sufficient amount of intelligence into his machine. In other words, the practise of the wireless art needs more pure science before it can expect to overcome the very serious interferences due to the action of the static. Ordinary electrical tuning will not do, because every system which is highly selective through ordinary tuning is also highly sonorous. Every tap of the static will cause it to vibrate and it will vibrate in the same way as when it is under the action of the signalling waves. We must look for some other form of electrical selectivity, and this is the last point which I wish to bring before you now, but only very briefly.

The eye sees a very narrow strip of wave frequencies which are sent from a radiating body; the ear hears a very narrow strip of wave frequencies which vibrating bodies can send out. Physiological optics and physiological acoustics deal with these remarkable facts. Now the reason why the eye is blind and the ear is deaf to an enormous range of frequencies is certainly not due to anything like ordinary selectivity produced by tuning. The selectivity must be due to something else. Physicists see resonance and tuning wherever they find selectivity, but it is high time to formulate broader views.

Fifteen years ago I published several investigations which deal with electrical motion in sectional wave conductors. One of these resulted in the now well-known loaded telephone line. I regret that the technical importance of this invention, by attracting too much attention, has overshadowed completely the full meaning of the general mathematical theory which underlies it. This theory says that sectional wave conductors can be made which will absorb almost completely all waves above or below a certain small range of frequencies, and the selectivity thus obtained has nothing to do with ordinary electrical tuning. In other words, the selectivity of the eye and of the ear can be imitated by coarse structures like sectional wave conductors. Electrical pulses produced by the static are for the most part very short and their action is equivalent to the action of highly damped electrical oscillations of very high pitch. This action can be entirely absorbed so that no part of it reaches the receiving apparatus of a wireless receiving station if between the antenna and the receiving apparatus a sectional wave conductor is employed which will not transmit electrical waves of a frequency higher than a given range of frequencies. The station becomes then an ear which is quite sensitive for frequencies which are in the vicinity of the signalling frequency, but which is stone deaf to frequencies which are considerably beyond this range as most static disturbances are. Similarly, a sectional wave conductor can be constructed which is quite responsive to frequencies in the vicinity of the signalling frequency, but absorbs almost completely everything below this range. My theoretical and experimental investigations encourage me in the belief that a perfect barrier has been found against disturbances due to the so-called static, and that the distances of uninterrupted wireless telegraphy and telephony will be very greatly increased.

M. I. Pupin

THE CALORIMETER AS THE INTERPRETER OF THE LIFE PROCESSES[1]

SHORTLY after the outbreak of the present war a scientific commission in Berlin reported that the quantity of energy units required during a year by 68,000,000 inhabitants in Germany amounted to about 57 thousand million calories, and that under changed conditions of dietary habits 81 thousand million calories would be available. In accordance with the requirements of the crisis the habits of the people were changed.

Our own Commission for Relief in Belgium forwarded food on the basis of the knowledge that 1,000 calories in cornmeal cost 11 mills, in wheat 14 mills, in rice 18 mills, in wheat flour 20 mills, in beans 29 mills, and in pork "fat backs" 28 mills.

All this was the world's recognition of the need of fuel for the life processes in human beings.

Rubner's work has made it possible to picture the energy liberated in various forms of living things. Thus Rubner estimates that a horse requires 11 calories per kilogram per day in order to maintain the normal life processes and for the fulfilment of the same necessities a man requires 30 calories per kilogram of body weight, a newborn mouse weighing one gram requires 654 calories per kilogram while a yeast cell weighing 0.000,000,000,5 gr. produces 1,743 calories per kilogram of substance, this also being the heat produced by a kilogram of diphtheria bacilli. The energy production in these lower forms of life was measured by determining the rise in temperature of the medium in which they lived when this was confined within the limits of a Dewar flask. The heat production of a kilogram of yeast thus measured was three fold that found for the same unit of mass in a newborn mouse, 58 times that of a man and 157 times that of a horse.

Although these values appear to be extremely variable, there is one unit of measurement which in mammalia is quite constant and that is the heat production per square meter of surface. Bergmann, in 1848, was the first to advance this hypothesis and a year later the French observers Regnault and Rieset stated that the heat production of sparrows per unit of weight was ten fold that of fowls, a phenomenon which they asserted was due to the fact that the smaller animals present a relatively larger surface to the surrounding air and thereby experience a considerable chilling, with the consequent generation of sufficient heat to maintain the normal body temperature. In 1883, Rubner published calculations which showed that the heat production of mammalia of various shapes and sizes was the same per square meter of surface. Figures are given such as 1,042 calories for man, 1,039 for the dog and 1,122 calories for the new-born mouse per square meter of surface during periods of 24 hours when the temperature of the environment is 15° C. and when moderate voluntary movements are permitted.

Further analysis showed Rubner that this evenness of heat production per unit of body surface was not due to any relation between the area of body surface and the area of cell surface within the organism. There are in one kilogram of body weight of man 150.2 square meters of such surface and each square meter of cell surface produces 0.2 calories per day. In the new-born mouse each square meter of cell surface produces eleven times this amount or 2.2 calories. It is of interest, also, to note that a kilogram of yeast cells presents a surface area of 600 square meters and at a temperature of 38°, or that at which mammalian cells exist, 1.25 calories per

[1] Read at the New York meeting of the National Academy of Sciences, November 16, 1915.

square meter of surface are produced in 24 hours, 8.34 grams of cane sugar undergoing inversion and fermentation during that interval. This reaction is independent of the strength of the sugar solution within the wide limits of 2.5 to 20 per cent. If the strength of the solution be at the maximum of normal reaction, or twenty per cent., the quantity of sugar utilized in twenty-four hours would be contained in a film 4/100 of a millimeter in thickness surrounding the cells. A like analysis shows that in man whose cells are bathed in a medium containing 0.1 per cent. of sugar the quantity necessary for the support of life during one day would be contained in a layer which if spread around the cell would be 5/100 of a millimeter in thickness.

From the calculation of the energy requirement in the food for the life of a nation to the energy liberated by a yeast cell in its simple resolution of sugar into alcohol and carbon dioxide is indeed a far cry, except as showing that the energy doctrine, as enunciated by Rubner, unites the world of living things.

In 1912 I calculated that the heat production of three quiet and sleeping dogs was 759, 748 and 746 calories per square meter of surface at an environmental temperature of 26°, that a dwarf produced 775 calories per square meter of surface, and that four out of five sleeping men investigated by Benedict showed an average heat production of 789 calories per unit of area. Only in the sleeping infant 7 months old investigated by Howland, did the metabolism appear out of the ordinary and reached a level of 1,100 calories, and this factor was specifically pointed out as indicating a higher metabolism in the youthful protoplasm than is present in the adult.

When the Russell Sage Institute of Pathology constructed in Bellevue Hospital an Atwater-Rosa calorimeter copied in the main after the successful models of Benedict, it became absolutely essential that some criterion of normal metabolism be established, as a basis from which one could estimate whether the metabolism of a patient under investigation was higher or lower than the normal. The severe criticisms of Benedict upon the method of estimating heat production from the unit of surface led to a very careful review of all the evidence and to new experiments. Du Bois, who took up this work, has used an accurate and ingenious method with which he has been able to actually measure the surface area of normal men. He and Mr. Delafield Du Bois have discovered that the formula heretofore used for estimating the surface area in man showed an average inaccuracy of 16 per cent. and a maximal variation from the normal of 36 per cent., this being found in very fat individuals. A new formula has been evolved which gives an average variation of $\pm$ 1.5 per cent. and a maximal variation of $\pm$ 5 per cent. Using the older formula of Meeh, the heat production per square meter of surface is 833 calories during 24 hours, but using the more accurate formula of Du Bois that rises sixteen per cent. to 953 calories. In normal adults of various shapes and sizes this is the *basal metabolism* as measured when the individual is resting and before the administration of food in the morning. The variation from this standard does not exceed 10 per cent. in 90 per cent. of the cases. The maximal variation is 15 per cent.

The critical studies of F. G. Benedict have been especially helpful in stimulating the reconsideration of all the data and methods in relation to this subject. Benedict is in agreement with Carl Voit when he concludes that the mass of active proto-

plasmic tissue determines the height of the metabolism. However, in the search for a standard upon which to calculate what would be the normal heat production of a man suffering from disease it is obviously impossible to measure the mass of active protoplasmic tissue. It is, therefore, most fortunate that the unit of surface area eliminates the same amount of heat in the normal adult within ten per cent. of a determined average.

The reason for this is not clear, but the fact is established. It is known that a regulating mechanism maintains the body temperature at a fixed point, though the reason for this is also undetermined.

The figures given hold true for the adult but are subject to variations due to age.

Murlin has pointed out that the newborn baby has a distinctly lower metabolism than normal and that this rapidly rises during the first year to a standard above the normal. It should be remembered in the first place, that the newly born may be considered in the light of an internal organ which has been protected from external stimuli. This is indicated by the work of Murlin upon the pregnant dog and from that of Murlin and Carpenter upon the human mother. The increase in heat production during the first months of the infant's life may be due to the union of the muscles with medullated nerve fibers. Furthermore, one finds on analysis that there is 24 per cent. of muscle tissue in the newly born baby as against 42 per cent. or nearly double that quantity in the adult. These proportions are reversed as regards glandular tissue, there being 47 per cent. of this tissue in the newborn and only 24 per cent. in the adult. It is this preponderance of glandular tissue in early life that may be the cause of the prevalence of the higher metabolism during the early period of growth. Du Bois has found that in a number of boys just before puberty the heat production is 25 per cent. above the normal and it is interesting to query whether this be due to glandular activity.

With the approach of old age the metabolism falls about ten per cent.; there is no longer quite the same intensity of oxidation as at the height of a man's virility.

In conditions of disease, as in those of health, the same materials, such as protein, fat and carbohydrate are oxidized and in the normal fashion, and they produce heat after the normal manner. The disease of diabetes presents a striking exception, as sugar may here remain unoxidized. In general, one may say that the intensity of the metabolism processes are little affected in many diseased conditions. In diabetes the heat production does not rise appreciably above the normal. The calorimeter in the hands of Du Bois and his fellow worker has shown that in severe anemias and in heart disease involving dyspnea, the heat production may increase. This is very probably due to the stimulus of lactic acid, a similar phenomenon being witnessed in a dog poisoned with phosphorus. In a typical fever such as typhoid the heat production may increase between 40 to 50 per cent. and in severe cases of exophthalmic goiter it rises to between 75 to 100 per cent. above the normal. It is fortunate that the ingestion of food which in the normal individual causes an increase in heat production, does not abnormally stimulate the fires of metabolism in these patients already suffering from intensified oxidation processes.

The inner process of heat production involves the interplay between the living cells of the body and the nutrient constituents of the fluids which bathe them. It has been known since the time of Lavoisier that the ingestion of food results in an increase in metabolism. In the presence of

abundant food the cells produce heat in increasing measure. Thus, after giving meat alone in large quantity to a quietly resting dog the heat production may be double that of the normal basal metabolism. The constituent amino-acids of protein are relieved of their NH_2 groups and the denitrogenized remainders are utilized for heat production, any excess being converted into glucose and retained in the organism as glycogen. The great rise in heat production is in large measure due to the direct chemical stimulation of the cells through the metabolism products of certain amino-acids. The proof of this lies in the fact that if glycocoll or alanine be given to the diabetic dog the heat production is largely increased, although these substances are not oxidized and there is therefore no evolution of heat from them, for they are converted into glucose and urea which appear in the urine. When the same method is applied to the study of the sugars, it fails to support the idea that the intermediary products of sugar metabolism directly stimulate the cells to a higher heat production. Thus, fructose administered to a diabetic dog caused no increase in heat production, although it underwent chemical change, for it was found as glucose in the urine. Since all the evidence regarding this reaction points to a preliminary cleavage of fructose which contains six carbon atoms into two molecules each containing three atoms of carbon and to the subsequent synthesis of these molecules into glucose, one may reason that the preliminary cleavage products of carbohydrate metabolism are not direct stimuli to protoplasm, as are those of amino-acids like glycocoll and alanine, but that normally the mere presence of a large number of metabolites of sugar results in their oxidation in increased measure.

Rubner has shown that when the yeast cell is bathed in a solution of sugar and peptone the protein is used for growth or cell repair only, while alcoholic fermentation furnishes the energy, and as before stated the quantity of this energy is independent of the strength of the solution. So also in a mammal such as the dog, if one give 50, 70 or 100 grams of glucose, the energy production increases in all cases to a level of about 30 per cent. above the normal. It appears that the cells by a process called "self-regulation" use the fragments of broken glucose up to a certain limit which is not transcended. Any excess of these fragments is converted into glycogen or into fat, a small quantity of energy being absorbed in the first process and a small quantity being liberated in the second. The result of this is that beyond a certain limit of carbohydrate plethora, the heat production in the dog scarcely rises, and this is analogous to the behavior of the yeast cell towards its nutritive environment.

The study of the intermediary metabolism upon which the total heat production of an animal is based, furnishes a fascinating field for the scientist, and it is also evident that the study of the fuel requirement of the human individual in health and in disease presents many problems of importance for the general welfare of the community at large.

Graham Lusk

OBSTACLES TO RESEARCH[1]

The duty of the university to investigate the unknown as well as to teach the known is clearly evident. In the performance of this duty, the importance of research work is emphasized in many ways. Promise of productive scholarship is a leading qualification demanded in selecting members of the faculty. Encouragement and facilities for original

[1] An address delivered before the Minnesota Chapter of the Sigma Xi Society, October 21, 1915.

work are freely provided. And yet we must confess that the outcome, broadly speaking, is somewhat disappointing, both here and in other universities. It is true that the results in some departments and in many individual cases are satisfactory. On the whole, nevertheless, considering our great opportunities, we seem to add relatively little to the sum total of human knowledge. Why? A recognition of the obstacles to research might enable us in some measure to overcome them. At any rate, the problem is worthy of our earnest and careful consideration.

Let us consider the problem from the biological point of view. The accomplishment of every human being (as of all living things) is the resultant of two factors: heredity and environment. In research work, as in all other lines of activity, the *limits* of possible achievement for each individual depend upon his innate talent, established through heredity. Within these limits, however, the *realization* of possibilities is conditioned by the environment. We must therefore distinguish clearly between (possible) capability or capacity and (actual) accomplishment in the field of original investigation.

The first and most important obstacle in research work is accordingly the limitation of capacity, which is determined by heredity. Since it is now too late to quarrel with our ancestors concerning the matter, as individuals we may as well recognize this as an insurmountable obstacle. From the broad university point of view, this fundamental obstacle may be partially removed by great care in the selection of faculty members. Geniuses are scarce, however, and competition for them very strong; so it is inevitable that even in the strongest universities the faculties must be made up of men with varying degrees of innate talent.

But while our heredity is beyond our control, our environment is not. At least we can modify the environment to a considerable extent. And this is a fact of tremendous practical importance. After all, environment does play an important part in determining both the quantity and the quality of our performance in all lines, including research work. If the environment is sufficiently unfavorable, even the highest genius is sterile. Of two men with equal native ability, one with better opportunity may be far more richly productive than the other. It is a case of seed and soil. The result is determined by heredity plus environment; or perhaps better, heredity *times* environment.

Geniuses are sometimes able to accomplish a great deal, even in a relatively unfavorable environment; but fortunately research work is not a province reserved exclusively for genius. It is encouraging to most of us to remember that the army of investigation requires private soldiers, as well as officers of various grades. Even moderate capacity does not preclude research work of real value. As expressed by John Hunter:

> A man with a sufficient fund of knowledge, and a close application to one art or science, will make great improvements in it though his talents may not be the best; or, in other words, though he be not a great genius.

Conquering the unknown in the field of knowledge is somewhat like civilization invading a new territory. A few bold and talented explorers may lead the way and blaze out new paths in the wilderness; but their excursions would be fruitless unless followed up by pioneer settlers, who by arduous labor develop the country and render its resources available for mankind. Moreover, even the explorer is in many ways largely dependent upon the knowledge and equipment furnished by others, his predecessors and his supporters.

Likewise, in the exploration of the field of knowledge, there is work for all. The history of science abundantly proves that brilliant discoveries and important generalizations usually rest upon a long series of accurate observations, requiring care and patience, but not great genius. A classical example is that of Kepler's laws of planetary motion, founded upon the extensive astronomical observations by Tycho Brahe. In biology, to substantiate and support the cell-doctrine of Schleiden and Schwann, and the doctrine of organic evolution of Darwin, has required an immense

amount of patient labor by a multitude of observers during the past century. Other examples could easily be cited in various fields. The plodders as well as the geniuses should receive their due share of credit for the progress of science.

The production of research work of merit is thus within the capabilities of every one worthy of membership in a university faculty. Doubtless some who are talented predominantly as teachers should devote themselves chiefly to this field, and others are especially fitted for administrative work; but it is desirable that every one should participate to at least a slight extent in research work. As a matter of fact, we may go still further in urging that the *spirit* of scientific research should pervade *all* education, from the kindergarten to the university. Mankind in general is still far from appreciating the fact that the method of science is not a mysterious gift of genius, but a practical tool in the discovery of facts and in their application to the problems of everyday life. As Professor Remsen so aptly expressed it in his address at the dedication of the chemistry building of the University of Minnesota last year, the scientific method is essentially this: "First study the facts; then draw your conclusions from them."

From this point of view, all our problems thus become research problems; and education is able to teach us how to solve them efficiently in proportion to the extent to which training is provided in the methods of original investigation. Thus all education should provide training in scientific research, differing in degree rather than in principle as we pass from elementary to higher education. President Hill (in a recent commencement address at the University of Minnesota) has well said that "The teacher should arouse the spirit of discovery as the first step in the process of learning." A more general recognition of the significance of scientific research for education, a correction of the prevalent error that research is a matter concerning only a chosen few, would remove an obstacle which prevents a more generous support of higher scientific investigation.

While all instruction should be permeated with the research spirit, a conscious effort should be made, especially in the university, to single out as early as possible those students showing unusual talent for original work, and to give them particular aid and encouragement. We must constantly emphasize the necessity for recognition of unusual talent, since otherwise our entire time and energy will tend to be exhausted in caring for the larger number representing mediocrity. This subject is well discussed in a recent report of the subcommittee on the selection and training of students for research (Committee of One Hundred of the American Association for the Advancement of Science), published in SCIENCE, September 17, 1915.

It is, however, not my present purpose to consider the message of science for education in general, but rather to discuss the specific obstacles met by university workers in the field of original investigation. Since we can not change our heredity, possibilities for improvement must be found in the environment. What factors in our environment affect our scientific productivity?

We might classify the environmental factors affecting our research work in two groups: mental and physical. In the first rank, I would place the factors determining our mental attitude toward research. I suspect that investigation lags more frequently from lack of sustained interest than from any other cause. It is doubtless true that one is usually most interested in what one can do especially well. And research ability, as we have already noted, is largely a hereditary matter. Nevertheless, our mental attitude is unquestionably influenced in large measure by the opinion of our colleagues. Appreciation by one's fellows is a most powerful stimulus. Thus a general recognition of good research work will greatly encourage the worker to persist in spite of all obstacles. If Sigma Xi can succeed in establishing a more enthusiastic *esprit de corps* among investigators, it will greatly help the cause of scientific research.

The physical factors affecting research work are also of importance. The obstacles under

this group include lack of material facilities, lack of time and lack of organization. Each of these may be briefly considered in turn.

The material facilities necessary for research include laboratories and equipment of various kinds, supplies, instruments, technical assistants, books, *etc.* It is customary to cite lack of adequate facilities of this kind to explain shortcomings in scientific productivity. And there is no doubt that more generous provision for these things would greatly facilitate many lines of research work. But, generally speaking, I believe that this factor is somewhat overrated. The man who does nothing because facilities are inadequate would usually accomplish but little even with unlimited resources. On the other hand, the man whose heart is in his research work will rarely fail to secure adequate support, if he perseveres and demonstrates his interest and capability.

Inadequate support of research work is sometimes ascribed to lack of appreciation on the part of university administrative officers, who control the purse-strings. This is usually an unjust accusation. University officers as a rule are keenly anxious to encourage and support research work, but they in turn are always more or less hampered by financial limitations. With the present evidently increasing popular interest in and appreciation of scientific work, however, we may confidently expect in the future more generous provision of funds available for this purpose. Even the "man in the street" can see how Germany has increased her efficiency by systematic encouragement of scientific research. America is likewise beginning to realize that this is not a luxury but a necessity, for which generous support must be provided.

Even more than lack of facilities, lack of time is an obstacle very frequently encountered by university research workers. Many university men are carrying a burden of routine teaching which, if well done, must greatly encroach upon the time absolutely essential for serious research work. In many cases, a considerable amount of routine administrative duties, committee work, etc., is added. Under these conditions, which shall be neglected—teaching, administrative work, or research? Or should one risk the danger of overwork by trying to keep up with all? Surely this is a question hard to answer. The proper solution is of course to provide a sufficient staff to handle the routine teaching and administration, and at the same time leave adequate time free for research. In a rapidly growing university, however, it is difficult to make this provision. But conditions are improving in this respect, and comparatively few men are so overburdened with routine work as to preclude a reasonable amount of time for research.

Lack of time for research work is often due not so much to the actual amount of other work as to waste of time. By carefully planning our university work, much time could be saved. There is too much "scatterment." All too frequently we allow minor routine duties to break in at all times. These minor details should be concentrated so far as possible at certain designated periods, so as to leave uninterrupted consecutive time free for research. A set of office-hours established and rigidly kept will gain a surprisingly large amount of time otherwise frittered away. Thus one serious obstacle to research may be readily removed.

Finally, I believe that another obstacle of importance in many cases is the lack of a proper organization of the research work itself. For the best results, careful, systematic planning is necessary. Too often investigation is taken up in a haphazard sort of way, which is likely to result in failure. While no rule can be made which will apply to all cases, it is certainly true that the topic to be investigated should be carefully considered before the work is undertaken. The literature should be scanned sufficiently to make sure that the contemplated problem has not already been solved, and to render available the experience of others in similar fields. Work should not be undertaken until the necessary facilities are assured to carry it through. In general, a broad fundamental problem of which successive phases may be worked out through a series of years will prove more profitable than a num-

ber of shorter, unrelated subjects of investigation. Wherever possible, cooperation with one's students or colleagues in research will usually yield better results, from the standpoint of economy in time and cost, than will individual efforts. Such matters may seem self-evident to some and trivial to others; but I feel sure that in many cases more attention to them would be well worth while. In short, system is as necessary for efficiency in research as in any other kind of work.

In conclusion, the main points may be emphasized as follows: Obstacles to achievement in research are due partly to inherent or hereditary limits of capacity, and partly to environmental factors. The latter, which are to some extent within our control, include factors determining the mental attitude, which is of primary importance. The remaining factors include the material facilities, increased support for which depends chiefly upon better appreciation by the public of the value of scientific work. Lack of time is often another important obstacle, which in part may be overcome by a more economic arrangement of routine duties. Finally an obstacle in many cases is the lack in the research work itself of systematic planning and organization, which is necessary for the highest efficiency.

C. M. JACKSON

INSTITUTE OF ANATOMY,
UNIVERSITY OF MINNESOTA,
MINNEAPOLIS

DR. CHARLES FREDERICK HOLDER

THE love of nature is so deeply planted in our hearts that even those who have passed most of their lives in the artificial atmosphere of cities respond quickly and warmly to the appeal made by scenic beauty and by the variety and charm of plant and animal life. Hence he who can successfully voice these sentiments and satisfy the desire for a better knowledge of the life, habits and instincts of the denizens of wood, vale and stream, is sure of wide recognition and appreciation.

It can safely be said that no one in our land has more perfectly realized these conditions than the late Dr. Charles Frederick Holder, who passed away on October 10, 1915, in his home at Pasadena, California. At once an enthusiastic sportsman and an enemy to all indiscriminate destruction of animal life, he possessed a rare blend of qualities sometimes regarded as incompatible one with the other. Something of his repugnance to the reckless slaughtering of animals characteristic of too many hunters, may possibly have been due to the fact that he came of stanch Quaker stock, one of his direct ancestors, Christopher Holder, having founded, in 1656, the first society of Friends in America.[1]

Charles Frederick Holder was born in Lynn, Massachusetts, August 5, 1851, and received his early education in the Friends' school at Providence, Rhode Island, and in Allen's preparatory school at West Newton, Massachusetts, as well as from private tutors; later on he developed an inclination toward naval life, and in 1869 entered the United States Naval Academy at Annapolis, but did not pursue the course there up to graduation. From his boyhood he showed the taste for hunting and fishing, and at the same time for the study of the habits of birds and fish, that was destined to grow with his growth and become the aim and pleasure of his life.

In 1871, though but twenty years old, he became assistant curator of the American Museum of Natural History in New York City, and held this position until 1875. The present writer cooperated with Dr. Holder for nine weeks in packing up the 1,000,000 specimens of the James Hall paleontological collection in Albany, prior to their transfer to the American Museum of Natural History in New York City. His marriage to Miss Sarah Elizabeth Ufford, of Brooklyn, took place November 8, 1879.

That one so devoted to nature study and to sport should be attracted toward California, especially toward southern California, can be easily understood; however, ill health was the determining cause of Dr. Holder's removal in 1885 to that state, where he established his

[1] This is related in Dr. Holder's interesting book, "The Holders of Holderness, or Pioneer Quakers."

residence in beautiful Pasadena, California's "Crown City." Here he carried on the literary work that had long taken up the greater part of his time, his numerous publications, both books and magazine articles, treating almost without exception of the beauties and mysteries of animate nature. His enthusiasm for his favorite theme and his happy facility in expression, combined to make the perusal of his books and papers both a pleasure and a stimulus for his many readers, as well in this country as abroad.

His influence in Pasadena, both social and educational, was felt and gratefully recognized by his fellow-citizens. He was chosen president of the local board of education, and a trustee both of Throop College of Technology and of the normal school, and was honorary curator of the college museum. From this institute he received a call to fill the chair of zoology, but did not accept. However, shortly before his death, he was appointed professor emeritus of the Charles Frederick Holder chair of zoology, the foundation of which was due to the instrumentality of his lifelong friend, advisor and encourager, Dr. George E. Hale, director of Mount Wilson Observatory. The income of the $50,000 raised for this foundation, goes, after Dr. Holder's death, to his widow for her lifetime.

All movements for the protection of animal life found in him an ardent supporter, whether as member of a society or as its presiding officer. He was long a member of the American Scenic and Historic Preservative Society, and in the Wild Life Protection League of America he was president of the department of southern California; he also belonged to the National Conservation Society, the American Game Protective and Propagation Association, the American Fisheries Society, and was president of the Los Angeles Society for the Protection of Game. He held the office of vice-president in the Audubon Society of California and in the Los Angeles Zoological Society. On the other hand, as a sportsman he has the credit of being the first to catch a leaping tuna, weighing over 100 pounds, with rod and reel, so that the catch was a legitimate result of a contest between a fisherman's skill and the strength and activity of his eventual victim. The rod used on this occasion is still to be seen at the Tuna Club on Catalina Island, of which Dr. Holder was the founder, his pen having been the most potent factor in making the island and its neighboring waters a favorite resort for fishermen. With Dr. F. F. Rowland he founded the "Tournament of Roses," one of Pasadena's great attractions.

Socially he was one of the most genial and sympathetic of men. He thoroughly enjoyed social intercourse with those whose interests were like his own, and was ever ready to aid them in realizing their aims. The leading social club of Pasadena, the Valley Hunt Club, was founded by him, and he was a member of the Twilight Club of that city. Other clubs to which he belonged as member, or honorary member, were: Sunset Club of Los Angeles, Tarpon Club of Texas, Aransas Pass Tarpon Club, South California Rod and Reel Club, Authors' Club of London, Sea Anglers' Club of Glasgow, British Sea Anglers' Society of London, Fly Fishing Club of London, Casting Club of Paris. In 1911 the Académie des Sports of Paris awarded him a gold medal. In a field less exclusively his own, he was a member of the New York Academy of Sciences, of the National Geographic Society and the Linnæan Society.

It is impossible to do more than mention a few of the more notable publications of Dr. Holder, as, for example, "Elements of Zoology" (1885), "Living Lights" (1887), "Louis Agassiz, his Life" (1892), "Along the Florida Reef" (1892), "Stories of Animal Life" (1900), "Half-Hours with Nature" (1901), "The Log of a Sea Angler," "Life and Sport in the Open in Southern California," "Big Game Fish at Sea" (1873–76). Among his almost innumerable magazine papers were a series of articles in *Forest and Stream*. This represents but a fraction of the literary work of one who by precept and example furthered the true interests of sport, and aroused and fostered in a large circle of readers a taste for the observation and study of nature.

The funeral services took place at his late residence, 475 Bellefontaine Street, Pasadena, the Rev. Robert Freeman officiating. There were present to do honor to his memory many prominent people from all parts of southern California. The active pallbearers, selected from among the intimate personal friends of Dr. Holder, were: C. D. Daggett, Dr. Francis F. Rowland, Walter Wotkins, Walter Raymond, William R. Staats and A. Stephen Halsted. Notable among the many letters of condolence received by Mrs. Holder, was a warm tribute of regard from Gifford Pinchot, who was in strong sympathy with Dr. Holder's tireless work in behalf of the conservation of wild life in our land.

GEORGE F. KUNZ

SCIENTIFIC NOTES AND NEWS

OFFICERS of the Royal Society were elected at the anniversary meeting on November 30 as follows: *President,* Sir J. J. Thomson in succession to Sir William Crooks; *Treasurer,* Sir A. B. Kempe; *Secretaries,* Professor A. Schuster and Mr. W. B. Hardy; *Foreign Secretary,* Dr. D. H. Scott; *Other Members of the Council,* Professor J. G. Adami, Sir T. Clifford Allbutt, Dr. F. F. Blackman, Dr. Dugald Clerk, Sir William Crookes, Professor A. Dendy, Professor J. Stanley Gardiner, Dr. H. Head, Mr. G. W. Lamplugh, Professor A. E. H. Love, Major P. A. MacMahon, Professor A. Smithells, Professor E. H. Starling, Mr. R. Threlfall and Sir Philip Watts.

M. MAURICE CAULLERY, professor of organic evolution in the University of Paris and president of the Zoological Society of France, has been appointed to be exchange professor from the French universities at Harvard University and will lecture at Cambridge during the second semester.

CHARLES CLARK WILLOUGHBY has been appointed director of the Peabody Museum of American Archeology and Ethnology of Harvard University.

AT the annual dinner of the Geographic Society of Chicago, which will be held in the Congress Hotel on January 8, the gold medal of the society will be presented to General William C. Gorgas.

DR. ERNST EHLERS, professor of zoology at Göttingen, has celebrated his eightieth birthday.

THE prize of the Martin Brunner foundation in Nürnberg has been awarded to Dr. Jakob Wolff, of Berlin, for his work on cancer.

ON November 23 at Aberdeen, S. D., the South Dakota State Academy of Science was organized with the following officers:

President, H. I. Jones.
First Vice-president, E. A. Fath.
Second Vice-president, O. R. Overman.
Treasurer, A. Mahre.
Secretary, R. J. Gilmore.

The meetings of the organization are held at the same time and place as the State Educational Association.

AT the annual meeting of the American Association of Clinical Research, held recently in Philadelphia, the following officers were elected: *President,* Dr. Coleman, of New York City; *First Vice-president,* Dr. William B. Snow, of New York City; *Second Vice-president,* Dr. Leon T. Ashcraft, of Philadelphia. Dr. James Kraus, of Boston, is *Permanent Secretary* of the organization.

AT the annual meeting of the Faraday Society, London, Sir Robert Hadfield was elected president.

THE following, as we learn from *Nature,* have been elected officers of the Cambridge Philosophical Society for the ensuing session: *President,* Professor Newall; *Vice-presidents,* Dr. Shipley, Dr. Fenton, Professor Eddington; *Treasurer,* Professor Hobson; *Secretaries,* Mr. A. Wood, Dr. Arber, Mr. G. H. Hardy; *New Members of the Council,* Dr. Bromwich, Dr. Doncaster, Mr. C. G. Lamb, Dr. Marr, Mr. J. E. Purvis.

THERE is also given in *Nature* the list of officers elected at the anniversary meeting of the Mineralogical Society which follows: *President,* W. Barlow; *Vice-presidents,* Professors H. L. Bowman, A. Hutchinson; *Treasurer,* Sir William P. Beale, Bart.; *General Secretary,* Dr. G. T. Prior; *Foreign Secretary,*

Professor W. W. Watts; *Editor of the Journal,* L. J. Spencer; *Ordinary Members of Council,* Dr. J. J. Harris Teall, F. N. Ashcroft, Professor H. Hilton, A. Russell, W. Campbell Smith, Dr. J. W. Evans, Dr. F. H. Hatch, J. A. Howe, T. V. Barker, G. Barrow, Dr. C. G. Cullis, F. P. Mennell.

Dr. W. F. M. Goss, dean of the College of Engineering of the University of Illinois, has made a final report to the Chicago Association of Commerce on his investigation in railroad smoke abatement. With this report Dean Goss finished his labors as chief engineer of the expert commission that was appointed five years ago, after having devoted two years to it, being on leave of absence from the university in order to serve the commission.

The annual gardeners' banquet in St. Louis, provided for in Mr. Shaw's will, was held on November 19 at the Liederkranz Club. Mr. John K. M. L. Farquhar, of Boston, president of the Massachusetts Horticultural Society, and past president of the Society of American Florists and Ornamental Horticulturists was the speaker of the evening.

Dr. Joseph E. Pogue, associate professor of geology and mineralogy of Northwestern University, will lecture before the Geographic Society of Chicago on December 16, his subject being "Through the Heart of Colombia."

At the recent National Conference on Marketing and Farm Credits held in Chicago, Dr. F. H. Newell, head of the department of civil engineering at the University of Illinois, gave an address in which he urged the adoption of a system of rural credits which would meet the needs of farmers operating irrigated lands.

The Long Fox lecture was delivered by Dr. Richardson Cross, at the University of Bristol, on December 1, on "The Evolution of the Sense of Sight."

The untimely death of Mr. Chas. F. Adams, well-known physics teacher of Detroit (October 29, 1914), has been the inspiration for many to join in a college scholarship fund in his honor. The Charles Francis Adams Memorial Scholarship Fund raised by citizens, teachers and former students, now amounts to $1,300, but it is expected will reach $1,500. Mr. R. V. Allman, former instructor in the University of Michigan, succeeds Mr. Adams. The Detroit Central High School is one of the pioneers giving a full year's junior college work in biology, chemistry, physics and languages, now accepted by the University of Michigan.

The medical staff and patients of the Workmen's Circle Sanatorium, Liberty, have adopted resolutions regretting the death of Dr. Edward Livingston Trudeau, who had for thirty-one years worked untiringly and unselfishly in the interest of the consumptive workingmen and women, and expressing their appreciation of his work by conferring on the hospital building of the Workmen's Circle Sanatorium, the name "Trudeau."

At a meeting of the directors of the Washington Association for the Prevention of Tuberculosis, resolutions were drafted paying tribute to the unselfish character of General George M. Sternberg, late president of the association, and to his valuable contributions to preventive medicine.

Orville Adelbert Derby, distinguished for his work in geology, died by suicide in Rio Janeiro, on November 27. He had been chief of the geological survey of Brazil since 1907 and previously since 1875 connected with the survey and the National Museum, except for two years when he was instructor in Cornell University. He was born in New York State in 1851.

Dr. Charles Callaway, of Cheltenham, who was one of the pioneers in the study of the Archæan rocks of the British Isles, has died at the age of seventy-seven years.

Nature records the death, in his eighty-sixth year, of Mr. Charles Fortey, who was for many years honorary curator of the Ludlow Natural History Society's Museum.

Mr. J. Sinclair, author of works on stock-breeding and agriculture, died on November 5 at the age of sixty-three years.

THE death is announced of Dr. C. J. Bouchard, emeritus professor of pathology in the University of Paris.

ALL persons who intend to present papers before Section E, geology and geography, of the American Association for the Advancement of Science, at the Columbus meeting, should submit title of paper and abstract to Professor George F. Kay, Iowa City, Iowa.

A NEW method of manufacturing sulphuric acid, for which advantages are claimed, is suggested in United States Department of Agriculture Bulletin No. 283, "The Production of Sulphuric Acid and a Proposed New Method of Manufacture." The essential difference of the method is that the gases employed are drawn downward through a spiral flue in place of being drawn through lead chambers or intermediate towers. It is asserted that the resistance of gases to the downward pull and the constant change in their course through the spiral tend to mix them very intimately. The fact that the gases constantly impinge on the walls of the spiral flue, which can be cooled either by air or water, makes it practicable to maintain the gases at a temperature most favorable for the efficient yield of sulphuric acid. In laboratory tests in which the spiral was utilized, practically all the sulphur dioxid was oxidized to sulphuric acid, only traces being lost through escape or in the system. The lead spiral, the author points out, however, is not intended to replace the Glover tower, nor to do away with the Gay-Lussac tower. It is believed that while the lead spiral will take considerable lead, the great reduction it will effect in the chamber space will make it possible to construct a plant with considerably less lead than is required in the ordinary chamber system. The new type of plant requires no other device to accelerate the reactions, occupies much less ground space, and would not need as large buildings, and therefore should decrease the initial cost of construction. The method, however, has been tried only on a laboratory scale, and the bulletin refuses to predict just how efficient the commercial plant would be, but states that all indications are that this method offers promise of being economically successful.

THE area of the Chugach National Forest, Alaska, which is to be crossed by the railroad that the government is building from Seward to Fairbanks, is reduced nearly one half by a proclamation, signed by President Wilson, returning approximately 5,802,000 acres to the public domain. This action follows classification of the land by the Forest Service showing that the areas involved are not of high enough timber value to warrant government protection, and means the largest elimination of national forest land ever made by a single presidential proclamation. The boundaries of the forest, as redrawn by the president's proclamation, now contain approximately 5,818,000 acres, supporting about eight billion feet of merchantable timber. On the area thrown out of the forest there is in the aggregate a large amount of timber, but it is so sparse and scattered as to be of little or no commercial value. The land remaining within the forest, however, contains the largest and most accessible supply of timber for the development of the great mineral fields to the north of Bering River, and is the region in which the Alaskan Engineering Commission has been authorized to cut 85 million feet of timber for use in constructing the government's new railroad. On account of the time required for cutting and seasoning construction timber, the commission has had to purchase some lumber from Washington and Oregon, but as cutting has already commenced on the Chugach, it is expected that the Alaskan timber will soon be serving the needs of the railroad builders. The lands eliminated by the proclamation are in three large tracts; one along the entire southerly slope of the Chugach Mountains, the second lying northeast of Seward, between Resurrection Bay and Kings Bay, and the third, northwest of the Kenai Mountains in the region around Tustamena and Skilak lakes. In addition, the towns of Hope, Sunrise, Kenai and Ninilchek are eliminated. According to the Forest Service, the chance of locating homesteads in the

excluded lands is extremely small, since they contain few agricultural areas, although in some localities there are said to be small patches suitable for farming.

We learn from *Nature* that the council of the Chemical Society has sent to every fellow a letter directing attention to the government scheme for the organization and development of scientific and industrial research. In accordance with this scheme, a committee of the privy council has been appointed, and also an advisory council of scientific men whose primary functions are to advise the committee of council on—(i) proposals for instituting specific researches; (ii) proposals for establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; (iii) the establishment and award of research studentships and fellowships. The council of the Chemical Society considers it to be the urgent duty of every fellow to render all assistance possible to the advisory council by suggesting suitable subjects for research. As pointed out in the White Paper, the results of all researches financed by public funds will be made available under proper conditions for the public advantage, and the council feels assured that every fellow will place patriotic duty before private gain at such a time. Suggestions for purely scientific researches will be appreciated, but those having a direct bearing on chemical industry and its promotion will naturally receive a preference.

Following Secretary Lane's instructions to put special effort into its potash investigations, the United States Geological Survey is publishing the suggestion that a possible source of potash may exist in the tailings piled up at the concentrating mills of the big copper mines in the west. The "porphyry" ores which are being mined by the millions of tons annually contain several times as much potash as copper, and this remains in the tailings at the mills, material already finely ground and in condition for treatment, as well as easily accessible for shipment. This potash, however, is locked up in the form of silicate minerals, and the commercial extraction of potash from silicates has been for several years the subject of earnest study by industrial chemists. If this problem can be solved, it would appear that a large tonnage of potash-bearing material is available in the Western States. The brief report issued this week by the Geological Survey (Bulletin 620-J) contains typical analyses of these "porphyry" ores from the largest copper camps in a half-dozen states, as well as tonnage estimates of the ore reserves and ore already mined and treated. A few check analyses of tailings are also published. Suggestion of a possible potash reserve in these tailings originated with B. S. Butler, the geologist in charge of the Survey's statistical study of copper, who has based this short paper upon the published analyses of specimens collected by the government geologists in their investigations of the mining districts. The significant fact regarding this possible source of potash is that in quantity it is more than adequate to meet all the needs of the country as measured by present consumption of potash. The problem of potash extraction from this by-product of the copper industry therefore becomes an attractive one for the chemical engineer and mineral technologist.

A press bulletin of the U. S. Geological Survey notes that for many years the origin of the peninsula of Florida has been the subject of speculation among scientists. Some sixty years ago the great naturalist Louis Agassiz advanced the hypothesis that the greater part of the peninsula had been produced during comparatively recent times by successive growth of coral reefs along its southern margin, which has thus been extended farther and farther into the waters of the Gulf. A few years later Joseph LeConte restated his view of the organic origin of Florida and suggested that the work of corals has been largely supplemented by mud and other sediments dropped by the Gulf Stream. This hypothesis was generally accepted as correct for many years, but in 1881 Professor Eugene A. Smith discovered that the greater part of the peninsula of Florida is underlain at no great depth by limestones which are not the work of corals and which were formed long before the Re-

cent epoch. For the last thirty-four years these fundamental rocks of Florida, often called the Ocala limestone, have been thought to be nearly equivalent in age to the Vicksburg limestone of Mississippi and Alabama and have been called the Vicksburg group. A short time ago C. Wythe Cooke, of the Geological Survey, discovered that the Ocala or so-called Vicksburg limestone of Florida contains many fossil remains of sea shells of the same species that occur in the marls near Jackson, Miss., and that are known to have become extinct before the rocks at Vicksburg were deposited. It therefore appears that the Ocala limestone is of about the same age as the Jackson formation and is considerably older than has heretofore been supposed. Instead of being of recent origin, as was thought by Agassiz and LeConte, the Floridian plateau was in existence during the Eocene era—probably two million years ago. A copy of Mr. Cooke's paper on the age of the Ocala limestone, which is technical and intended mainly for the use of professional geologists, will be sent free on application to the Director, United States Geological Survey.

UNIVERSITY AND EDUCATIONAL NEWS

MRS. RUSSELL SAGE has given Syracuse University a fund to build a college of agriculture as a memorial to her father, Joseph Slocum. The building is to cost several hundred thousand dollars, the exact sum to be decided later. The site for the building is to be determined at a meeting of the university trustees, December 14. Construction will be started early in the spring.

A NEW building will be constructed for the University of Illinois Medical School in Chicago for the clinical courses. The initial cost is to be about $100,000, which will pay for one wing. This will be added to later as the demand for room increases.

THE trustees of Delaware College have made plans for the expenditure of a gift of $500,000 to the college by an unnamed donor. A report submitted by H. Rodney Sharp, chairman of the Plans and Development Committee, which was approved by the board, showed that $250,000 will be used for a science hall to house the agricultural and chemical departments, $75,000 to remodel the old dormitory building and turn it into a commons for the students, and $200,000 will be set aside for maintenance.

FIRE early on December 7 destroyed the Thompson chemical laboratory of Williams College, a three-story brick structure, loss of which is estimated at $100,000. The fire started in a workroom on the first floor from spontaneous combustion, according to the college authorities and quickly spread through the building.

WARSAW UNIVERSITY and Warsaw Observatory have been transferred by the Russians to Rostow-upon-Don. At the same time the German government has reestablished the University of Warsaw, and added a faculty of medicine. Dr. von Brudsynski has been appointed rector, and Professor Wilhelm Paszkowski, in charge of the academic information bureau at Berlin, has been sent to Warsaw to advise on the reorganization of the university.

DR. EDWIN B. CRAIGHEAD, whom the state board of education failed to reelect as president of the University of Montana, has been elected commissioner of education of the State University of North Dakota. The three professors of the University of Montana which the board of education failed to reelect, Professor Mary Stewart, dean of women, Dr. T. B. Bolton, professor of psychology, and Dr. G. F. Reynolds, professor of English, have been reelected. They have, however, been given leave of absence for the coming year.

DR. WILLIAM OPHÜLS, professor of pathology, has been appointed acting dean of the Stanford University Medical School, in place of Dr. R. L. Wilbur, whose term as president of Stanford University begins January 1, 1916.

AT the University of Kansas, Dr. C. H. Ashton has been promoted from an associate professorship to a full professorship of mathematics.

MISS GERTRUDE I. MCCAIN has been appointed professor of mathematics in the Western College for Women, Oxford, Ohio.

DISCUSSION AND CORRESPONDENCE

A REMARKABLE ECLIPSE

TO THE EDITOR OF SCIENCE: Eclipses of the sun and moon occur with such frequency and are so similar in character and appearance that a distinction between them sufficiently great to be noticed by the uncritical observer would seem to be out of the question. The cause of eclipses is well known, and as they may be easily calculated the times of their occurrence and nature of their appearance are always published in the Nautical Almanac two or three years before they actually take place. Total eclipses of the sun have for many years afforded the necessary darkness for observing the heavens in close proximity to the sun; and numerous expeditions have been sent to distant parts of the earth in order to take advantage of the few moments of additional darkness thus afforded; and much interesting and useful information concerning the physical constitution of the sun has been obtained in this manner. At the present time, however, the chief importance of eclipses lies in the opportunities they afford for testing the accuracy of the calculations of mathematicians, and the correctness of the physical theories on which such calculations are based; and for this purpose the distinction between partial and total eclipses is of little importance.

In the year 1915 there were only two eclipses, both of the sun. The first occurred on February 13 under ordinary circumstances; the central eclipse began at sunrise in the Indian Ocean a few degrees to the southward of the island of Madagascar; passing along the northwestern coast of Australia, it crossed the island of New Guinea and ended at sunset in the North Pacific Ocean. The second eclipse took place on August 10; beginning at sunrise a few degrees to the southward of the Japanese Islands in the North Pacific Ocean. It moved to the eastward a few degrees southward of the Sandwich Islands at noon, and ended at sunset in the South Pacific Ocean. These two eclipses were very similar in character in so far as outward appearances are concerned. Their relative importance arises from the very dissimilar conditions under which they took place. In the eclipse of August 10 the centers of the *sun, moon* and *earth* were very nearly *in the same straight line*. I have examined the record of all the eclipses that have taken place since the year 1767; and I find that in the year 1903 there were two very similar eclipses; one of which took place on February 21 and the other on August 17 of that year.

It has, therefore, been *one hundred and twelve years* since a similar eclipse happened; and I find that the next similar eclipse will occur on July 11, 1991, or *seventy-six years from the present time*. It is, therefore, only on very rare occasions that such eclipses take place and this fact seems worthy of mention in the historical record of important eclipses.

It may, however, interest the reader to know how or why I happened to make this important discovery, as it has been many years since I was engaged in the discussion of eclipses for chronological purposes. I will, therefore, give a brief account of my investigations which so happily led to this discovery.

In the early summer of the year 1906 I was much embarrassed by a superfluity of leisure, and unable to pass my time agreeably with nothing to do. I had then recently been reading G. H. Darwin's interesting book on "The Tides and Kindred Phenomena," and learned that the mathematical theory of the tides was in a very unsatisfactory condition. I had read in my younger days the explanations of the tides by Newton and by Laplace. These explanations seemed so *plausible* that I then accepted them as correct. But as I had devoted the greater part of my life to the discussion of gravitational problems, the thought occurred to me that possibly a new discussion of an old problem might throw additional light upon a subject which was confessedly very obscure. I therefore concluded to undertake a critical discussion of the theory of the tides, and the discovery of the remarkable eclipse came as a bi-product of that discussion. My leisure has

since been pleasantly devoted to a study of the tides and other kindred problems.

In my investigation of the tidal problems I have based my work on the two following postulates; namely:

FIRST: *If a solid body of any figure whatever be covered by a fluid in equilibrium, the gravity at every point of the surface will be the same;* and

SECOND: *If the fluid covering a solid body be free to flow, and the gravity at different points of its surface be disturbed in any manner whatever, the fluid will flow from points where gravity is less to points where gravity is greater; and it will continue to flow until the gravity at all points of the surface becomes equal.*

If these postulates in regard to the equilibrium of fluids be correct the problem of the tides becomes greatly simplified, and instead of being the most *difficult,* it becomes the *simplest* problem of celestial mechanics. For it is a very simple problem to calculate just how much the earth's gravity at any point of its surface is affected by the attraction of the sun and moon. Now when the sun or moon is overhead we know the gravity at the earth's surface directly underneath them is lessened, and we also know that the gravity at all points where the sun or moon is in the horizon is increased by their attraction. It therefore follows from the second postulate that the water directly under the sun or moon will flow away towards the horizon in every direction; and instead of being heaped up under the moon as claimed by Newton and his successors, will be dispersed along a great circle of the earth whose pole is directly under the sun or moon, thus making a thin ribbon or narrow zone of high water of uniform depth and extending completely around the earth, instead of being piled up in the form of protuberance under the moon.

It also follows that there will be a zone of low water directly under the moon instead of a protuberance of high water as claimed by Newton.

Now since there are two disturbing bodies, the sun and the moon, acting independently of each other, it is evident that there will be two independent high-water waves passing completely around a great circle of the earth; and since all great circles intersect or cross each other at opposite extremities of a diameter, it follows that there will always be two points of intersection, or two places of high water, which may be observed at all times, provided we know where to look for them. It also follows that high tides are not restricted to the times of new and full moon, but exist at all times.

The problem of the tides is therefore greatly simplified and reduced to one of finding where the high-water waves produced by the attraction of the sun and moon cross each other, for at these points the single wave is equal to the sum of the two separate waves; and the computation of the places where the tidal waves cross each other is very easy and much simpler than the computation of an eclipse.

The plane of the solar tidal wave is always perpendicular to the ecliptic, and passes through the center of the earth and poles of the ecliptic; and its position is known at all times. The plane of the lunar tidal wave is always perpendicular to the plane of the moon's orbit; but as the moon's orbit is inclined to the ecliptic by about 5°, it follows that the poles of the moon's orbit are always at a distance of 5° from the poles of the ecliptic. But the inclination of the moon's orbit to the ecliptic is always the same, while the nodes of the orbit on the ecliptic are in motion, and perform a complete revolution in about nineteen years. It follows from this that the poles of the moon's orbit move in a small circle of 5° radius around the poles of the ecliptic, making a revolution in nineteen years. The position of the lunar tidal wave thus becomes known at all times; and since the position of the solar tidal wave is also known at the same time, it becomes an easy matter to calculate the place of their intersection, which is the place of high tide.

Now since the moon's nodes are moving backward on the ecliptic 1°.5649 during each lunation, it follows that the tides of no two consecutive lunations will be precisely the same; but they may be more easily calculated than most other celestial phenomena.

In the early spring of the present year (1915) I had so far completed the construction of mathematical formulas for the computation of the tides, that I actually computed the latitude at which the two tidal waves crossed each other at noon of each day during the lunation between May 13 and June 13. This calculation led to the discovery that, whatever may be the relative declinations of the sun and moon at the moment of conjunction or opposition in right ascension, the two tidal waves will always cross each other exactly at the equator; and at the distance of 90° both east and west from the meridian on which the sun and moon are situated. During this lunation the two tidal waves crossed each other at an angle which varied between 4° 20′ and 90°; and the latitudes at which they crossed each other were less than 40° during about *three* days, at the times of new and full moon; while during the twenty-six or twenty-seven remaining days of the lunation the high water was confined within the latitude of 45° and 70°, making a *typical* high-water zone of about 25° in breadth.

Now it will be remembered by readers who are familiar with tidal history, that both Newton and Laplace were greatly embarrassed by the fact that the highest tides did not occur at the time when the acting forces were the greatest, but about a day and a half later; and in order to explain this default of theory, they were obliged to *assume* the operation of *fictitious* or *imaginary causes.* The observations on which their theories were based were made in southern England or northern France, in latitudes in which the united tidal wave did not *usually* reach until about a day and a half *after* the time of new or full moon; and the reason it was not observed was not on account of its non-existence but because it was on duty in another place.

We shall now consider the united tidal wave during the lunation beginning with the full moon of July and ending with that of August. According to the data given in the *American Ephemeris,* the two tidal waves at the instant of conjunction on August 10 made an angle with each other amounting to only 43.8″; so that they were practically superposed the one upon the other throughout their whole extent and reaching entirely around the earth. But as the lunar tidal wave travels over the earth's surface about thirteen times as fast as the solar tidal wave, they soon part company near the equator, each wave revolving around its own polar axis; and at the end of a single day the latitude of the united tidal wave will be found at 61° 40′ and the two tidal waves will cross each other at an angle of about 11° 20′. The united tidal wave will then remain on or very near to the parallel of 62° of latitude until near the end of the lunation; and there would be a daily succession of uniformly high tides on that parallel of latitude during nearly a whole month.

We have thus far considered only that portion of the tidal waves which rises *above* the normal surface of the ocean; but the water can not rise at any given place on the earth's surface without an equivalent depression at some other point; and a correct theory of the tides will explain equally well all the conditions incident to their formation. Now we know that the earth's surface-gravity is *diminished* by the attraction of the sun and moon at all points of the surface that are less than 54° 44′ of angular distance from those bodies, and *increased* for all greater distances. It therefore follows that all fluids that are under the sun and moon and are free to flow, will flow *away* from the point directly under the sun or moon, instead of *towards* it, as required by the present accepted theory of the tides. This follows for two reasons: *First,* because the earth's gravity is greater in that direction, and, *second,* because the *tangential* forces of the sun and moon actually *push* all bodies in that direction. This is one of the most beautiful and interesting consequences arising from the gravitation of matter; for, were the manner of its action to be reversed, the earth would no longer be habitable by man or beast; for the sun would be hidden by a perpetual cloud by day, and the moon by night; and neither of the luminaries would be visible except at rare and uncertain intervals.

Sir John Herschel in his "Outlines of

Astronomy" has called attention to the *unexplained fact* that the *full moon* tends to disperse the clouds under it. This follows as a necessary consequence of gravitation; but it is not restricted to the *full moon*, but is in active operation at all times by both sun and moon. The fact is however most easily observed at the time when the sun is absent.

Incidentally we may mention that were the moon's orbit in the plane of the ecliptic, the eclipse conditions of the tenth of August would be mostly repeated at each new moon; but the tidal phenomena would be fundamentally different. In the supposed case the crossing of the two tidal waves would be constantly at the pole of the ecliptic during the whole lunation, and the high tides would be confined to the latitudes of the arctic and antarctic circles. If, at the same time, the earth's equator were shifted into the ecliptic, there would be a *constant elevation* of water at both poles of the earth, while all other places on the surface of the earth would have four simple tidal waves each day. The general problem of the height of the tidal wave at any time and place on the earth's surface can not be considered here, but tables for that purpose have already been computed, though still unpublished.

We see from this exposition of the subject that all the infinite variety of tidal phenomena are fully explained by the operation of the forces of gravitation as developed under existing conditions in the solar system. The eclipse of August 10 represents a case in which the forces of the sun and moon act in perfect harmony during a few minutes of time; but it recurs at such infrequent and uncertain intervals that nothing useful can be learned from a single performance unless there be some known theoretical connection with preceding and subsequent events. The problem of the tides, which has been aptly called the *"Riddle of the Ages,"* and designated in despair by an ancient philosopher as *"the tomb of human curiosity,"* may therefore now be considered as completely solved.

JOHN N. STOCKWELL

CLEVELAND,
November 4, 1915

ON THE DEGREE OF EXACTNESS OF THE GAMMA FUNCTION NECESSARY IN CURVE FITTING[1]

THE note by Mr. P. F. Everitt in a recent number of this journal[2] discussing an earlier note by the present writer[3] seems so likely to obscure the essential point and purpose for which the earlier note was written that it appears desirable to advert to the subject once more.

In practical biometric work the gamma function is *chiefly* (though of course not entirely) used in connection with the fitting of Pearson's skew frequency curves, where such function appears in the expression for y_0. In other words, the exactness of approximation to the gamma function in these cases can affect nothing but the calculation of the ordinates and areas of the fitted curve. The writer finds it difficult to conceive of such circumstances in the ordinary prosecution of practical statistical researches as would necessitate or warrant the calculation of the ordinates or areas of a frequency curve to more than two places of decimals. This being the case, it seemed desirable, in the earlier paper, to call attention to the fact that a quite sufficiently "exact" approximation to the values of the gamma functions could be made by simple interpolation in a table of log Γn.

In order that the statistical worker may form his own judgment as to what degree of exactness in approximating the gamma function is necessary in calculating y_0, Table I. is presented. This table shows, for four different skew frequency curves, the change produced in y_0 by altering the logarithm of the term involving gamma functions by the following amounts: .0000001, .000001, .00001, .0001 and .001. The curves used for illustration are taken from Pearson's memoir "On the Mathematical Theory of Errors of Judgment, with Special Reference to the Personal Equation."[4]

The curve marked I. in the table is Pear-

[1] Papers from the Biological Laboratory of the Maine Agricultural Experiment Station, No. 90.

[2] SCIENCE, N. S., Vol. XLII., pp. 453–455, 1915.

[3] SCIENCE, N. S., Vol. XLI., pp. 506–507, 1915.

[4] *Phil. Trans.*, Vol. 198*A*, pp. 235–299, 1902.

son's "Bright-line" (3) curve[5] and has the equation

$$y = 53.359\left(1+\frac{x}{11.0856}\right)^{3.96621}\left(1-\frac{x}{14.4504}\right)^{5.17262}.$$

Curve II. is Pearson's "Bisection" (3) curve[6] and has the equation

$$y = 71.56246\left(1+\frac{x}{11.349400}\right)^{5.41665}\left(1-\frac{x}{6.998136}\right)^{3.33995}.$$

Curve III. is Pearson's "Bisection" (2–3) curve[7] and has the equation

$$y = 59.43126\left(1+\frac{x}{16.16672}\right)^{9.763885}\left(1-\frac{x}{13.55284}\right)^{8.185180}.$$

Curve IV. is Pearson's "Bisection" (1–2) curve[8] and has the equation

$$y = 56.2136\left(1+\frac{x}{28.15012}\right)^{35.390655}\left(1-\frac{x}{37.69023}\right)^{47.384605}.$$

It will be noted that these are all Type I curves and represent a rather wide range of values of the a's and m's. The expression for y_0 in a Type I curve is

$$y_0 = \frac{N}{b}\cdot\frac{m_1^{m_1}m_2^{m_2}}{(m_1+m_2)^{m_1+m_2}}\cdot K,$$

where

$$K = \frac{\Gamma(m_1+m_2+2)}{\Gamma(m_1+1)\,\Gamma(m_2+1)}.$$

The table shows the change in the maximum ordinate, y_0, produced by altering $\log K$ to the amount indicated.

TABLE I

Showing the Maximum Effect on an Ordinate of the Curve Produced by a Change in the Value of the Log Gamma Term of the Indicated Amount

Curve	Amount of Change in Log K				
	.0000001	.000001	.00001	.0001	.001
I......	.00002	.00013	.00123	.01229	.12303
II.....	.00002	.00016	.00164	.01647	.16496
III...	.00001	.00014	.00137	.01369	.18700
IV....	.00001	.00013	.00130	.01295	.12958

[5] *Loc. cit.*, p. 287.
[6] *Loc. cit.*, p. 288.
[7] *Loc. cit.*, p. 288.
[8] *Loc. cit.*, p. 289.

From this table it is evident that:

1. An alteration of as much as one in the third decimal place in $\log K$ makes a change in the maximum ordinate of between 1 and 2 in the first decimal place, an amount practically negligible in many curve-fitting studies.

2. A degree of approximation to $\log \Gamma(n)$ such as is obtained by interpolation from a table of $\log \lfloor n$, when *only second differences* are used in the interpolation,[9] involves errors in the fourth decimal place in $\log \Gamma(n)$, or the fifth for values of $n > 25$ *circa*. These mean errors of the order of .02 *ca.* in the maximum ordinate (and, of course, smaller absolute errors in all other ordinates).

3. Interpolation from a table of $\log \lfloor n$ using second differences is, as we concluded in the earlier paper, quite sufficiently exact for all practical curve-fitting purposes. If any one desires to use ten-place logarithms or some other method, and make all his computations precisely exact to seven (or for the matter of that to 15, 20 or 50) places of figures he may, of course, do so. It is reasonably open to question, however, whether the *additional* contributions to knowledge which may fairly be expected to accrue from such procedure are likely to be of such magnitude or originality as to justify the labor.

RAYMOND PEARL

THE ORIGIN OF LOST RIVER AND ITS GIANT POTHOLES

IN a short article in SCIENCE in 1913,[1] Mr. Robert W. Sayles, of Harvard University, described and sought to explain the block-filled gorge and giant potholes of Lost River, in the Kinsman Notch, New Hampshire. During a first visit to the place, last summer, I saw certain features which seem worthy of attention, in formulating any working hypothesis of the origin of the phenomena.

As Mr. Sayles stated, Lost River is a small stream which flows eastward from the notch between Mt. Moosilauke and Mt. Kinsman, eddying and cascading beneath a deep pile of huge angular blocks and rifted ledges for a

[9] *Cf.* Table I. of the writer's earlier paper.
[1] Vol. XXXVII., pp. 611–613.

distance of over a quarter of a mile. The ledges and fragments are all of one type of rock—a coarse granite gneiss—which also outcrops in cliffs on the spur of Mt. Kinsman immediately above the gorge of Lost River, and appears in a talus-like mass of blocks on the steep slope between these cliffs and the gorge. In many cases the blocks appear to have been shifted very little from the ledges against which they lie in tipped or overturned positions; in other cases they are poised in such a way as to make it seem likely that they have been moved a considerable distance. The potholes in question include several semi-cylindrical pits or alcoves of from 15 to 25 feet diameter, and numerous holes and curved channels of much smaller size, similar to the potholes at Agassiz Basin, four miles down the stream. The giant potholes are in no case complete or even approximately so, but appear to have been cracked up and dislocated by the same agency which jostled the blocks generally, along the line of the brook.

In his paper Mr. Sayles considered three agents as possible factors in the breaking up of the ledges and scattering of the blocks: (*a*) frost action, (*b*) disruption by a moving glacier, and (*c*) earthquake movements along the line of the gorge, attended by rock falls from the cliff above it. He considered frost action inadequate because of the depth to which the ledges have been ruptured and displaced, and because in the lowest caverns there are "cases where blocks which have slipped from between other huge blocks in place have left the upper and lower blocks entirely unmoved in the solid ledge"; he rejects disruption by the moving ice sheet for the same reason, adding to it the circumstance that no erratic material occurs among the blocks, and that in one case a block has been shifted four inches against the direction of advance of the ice sheet. He adopts the theory of earthquake movement and rock fall because of the close association of the blocks of the gorge with the inclined heap of blocks on the overhanging slope, on the one hand, and with the cracked and torn ledges beside the stream on the other; because of lateral movements among the blocks, of the pell-mell manner in which they are heaped, and because of "smooth slickenside-like patches." It is conceived that after the potholes had been excavated, by a large glacier-fed torrent heading in the Kinsman Notch, an earthquake, originating along the line of the gorge, cracked the river-worn ledges and jostled the fragments, shaking down masses, at the same time, from the cliffs on the hill near by.

After looking over the phenomena at Lost River, it does not seem to me that the facts warrant a preference for the earthquake theory over that of glacial sapping and frost action; nor do I feel convinced that the "giant potholes" are products of torrent action. My reasons are these: (*a*) Positive evidence of earthquake movement seems to be meager if not wholly absent. I did not see the "slickenside-like patches" mentioned by Mr. Sayles, nor any other marks of faulting, although I looked for them. The presence of one or two such surfaces, however, even if *bona fide* slickensides, would not necessarily prove postglacial faulting; for small faults, probably of earlier date, are common throughout the White Mountain region. If, as Mr. Sayles supposes, the earthquake rift follows the gorge, it would be natural to expect slickensides to be extensively and distinctly developed. (*b*) The presence of the inclined heap of blocks at the foot of the cliffs, near the head of Lost River, does not seem to me to demand an earthquake. It is well known that rock falls may result from other causes. One may suppose, for instance, that during the evacuation of the notch by the ice sheet, insecure masses of rock on the crags above Lost River, and angular fragments of the same, occupying an englacial position in the ice near by, would slide or fall to the ground as soon as their support vanished, and would produce a heap of blocks such as we see here. In the transportation of these rock falls to points beyond the foot of the cliffs, an inclined floor of stagnant, melting ice might play an important part. It is also conceivable that the production and accumulation of talus, by ordinary processes, might proceed at an ab-

normally rapid rate during the seasons immediately following the retreat of the ice sheet, and that a mass of angular blocks might be left which, because of its uniformly weathered aspect, would appear to have gained little or nothing from annual frost action within more recent time. In either case, an earthquake would be unnecessary to the theory. (*c*) I agree with Mr. Sayles that the extent of fracturing and dislocation in the gorge itself is too great to be attributed to frost action under ordinary circumstances, both as to the depth reached and the amount of movement registered by the blocks; yet I can not see why plucking or quarrying of blocks by the ice sheet, supplemented by abnormally severe freezing and thawing, as the last vestiges of the ice sheet melted away from the pass, is not a perfectly valid alternative hypothesis. In plucking a large joint block from its place in the ledge, the ice sheet might rotate it so that one end of the block would be moved a few inches in a direction opposite to glacial movement, while the other end was moved forward. Even a case where a block had been moved bodily in a direction opposite to glacial movement, but through a space of only a few inches, as reported by Mr. Sayles, could be accounted for by the action of ice in crevices and angular "cavities" between the blocks at the close of the period of actual glaciation, when the ice surrounding the blocks had lost its ability to move *en masse*, but expanded and contracted in response to temperature changes, somewhat as capillary water and frost behave, in crystalline rocks, but on a much large scale. "Lateral movement" among the blocks, and "pell-mell arrangement" would be natural results of this type of ice action.[3] For these reasons it seems to me that the facts thus far reported do not demand the occurrence of an earthquake at Lost River, but are adequately met by the hypothesis of glacial plucking, followed by rock falls and frost work on a scale larger than has been possible since the last remnants of glacial ice vanished from the Kinsman Notch.

[3] See paper by J. B. Tyrrell, on "Rock Glaciers or Chrystocrenes," *Journal of Geology*, Vol. XVIII., 1910, pp. 549–553.

The size of some of the "giant potholes" is extraordinary. Although they may have been produced by a glacial torrent passing through the notch and on through Agassiz basin, where tortuous channels and large torrent-worn cauldrons are well developed, there are two features which lead me to question the reality of such an origin. (*a*) In more than one place, where a concave niche or alcove in the wall of the gorge suggests the side of a pothole, from which the other sides have been removed, I saw a curved joint crack in the ledge, one or two feet back of the concavity, and approximately concentric with it. The detachment of the intervening concavo-convex slab, by frost or glaciation, would have left an alcove equally cylindrical in form to, but of larger radius than the "pothole." (*b*) I was shown by Mr. E. R. Grinnell, superintendent of the reservation, examples of blocks with convex sides, which seem to match the concave niches or incomplete "potholes." One of these abuts against one of the giant potholes, near "the guillotine," and from its shape and form a pegmatite vein which traverses it appears to have dropped from the side of the ledge so as to produce what at first sight would be accepted as part of a huge pothole. Nowhere else have I seen examples of joint cracks with such sharp curvature, yielding partial cylinders of 15 to 25 feet diameter; but their existence here is certain. The question whether the giant potholes are surviving portions of real, torrent-carved potholes, or are imitative forms left by the extraction of joint blocks with curved sides can only be settled by careful measurements of the concave and convex surfaces and a geometrical study of the relations between the ledges and the blocks which still rest against them. As yet no large water-worn boulders seem to have been found in the largest "potholes."

As regards both the true character of the giant potholes, and the earthquake theory, it appears, therefore, that the geological history of Lost River deserves further study.

J. W. Goldthwait

Dartmouth College,
October 2, 1915

SCIENTIFIC BOOKS

Feeble-mindedness: Its Causes and Consequences. By H. H. Goddard. New York, Macmillan Company, 1914. Pp. xii + 599.

Like all of Goddard's writings, this is full of interest for the large number of those who, in these days of prolonged peace at home, have the privilege of considering social problems. If we, too, were at war, with us, also, "social problems" would sink into utter insignificance beside that of national existence.

Goddard's book may be divided into four parts, (1) the definition and scope of feeble-mindedness, (2) family histories of the feeble-minded, (3) "causes of feeble-mindedness"—with special reference to heredity and (4) some practical applications—eugenical and other.

1. The definition of feeble-mindedness accepted by Goddard is "a state of mental defect existing from birth or from an early age and due to incomplete or abnormal development in consequence of which the person affected is incapable of performing his duties as a member of society in the position of life to which he was born." This is a good definition. It follows, at once, as a corollary that feeble-mindedness is not a biological, but a *social* term; that many a person whom we regard as mentally unfit might not be feeble-minded in his native country of Central Africa or even the Adirondack Mountains, for he might be capable of performing the simple duties of the chase and fighting or rough agriculture demanded "in the position of life to which he was born." If we consider separately the higher grades of the feeble-minded, the morons, the non-biological nature of feeble-mindedness is still more obvious; "one . . . *incapable* from mental defect existing from birth . . . (*a*) of competing on equal terms with his normal fellows or (*b*) of managing himself and his affairs with ordinary prudence." Accepting this British definition, Goddard discusses the kinds of people to be included in the moron group of feeble-minded and the anti-social acts they perform. Thus, he considers criminality, alcoholism, prostitution, pauperism and truancy and finds that of criminals at least 50 per cent. are "defective"; at the root of much intemperance "feeble-mindedness" lies; "50 per cent. of prostitutes are feeble-minded"; "50 per cent. of the inmates of our almshouses are feeble-minded," and of truants 80 per cent. are feeble-minded. These are truly striking figures. But as the reviewer has considered this discussion he has felt as if groping in a fog. If feeble-mindedness is a social and relative term how can we seek to find a definite percentage of it in any class by some absolute standard, like the Binet test? Also what is the "mind"; shall we define it as including "intelligence" only, which seems to be the thing measured by the Binet scale, or shall it include "emotional control" which is clearly not measured by the Binet scale? Yet, is it not lack of emotional control that is at the bottom of much so-called crime, alcoholism, sex offense and truancy? And is it not also true that the question of the degree of correlation between "intelligence" and "emotional control" remains largely an academic one?

It seems to the reviewer more significant to inquire more deeply into the causes of any anti-social act than to classify the offender as feeble-minded or not feeble-minded by the Binet or other scale. It seems to the reviewer that anti-social behavior (*i. e.*, offense against the mores) may have the following bases:

(1) *Ignorance of the mores, merely through* lack of opportunity to learn the mores (the merely improperly taught offender).

(2) Ignorance of the mores through lack of capacity to understand what society expects (the feeble-minded offender, *sensu strictu*).

(3) Knowledge of the mores, accompanied with a social blindness—an inability to have the action controlled by a knowledge of what society expects of one—because of a lack of the gregarious, social or altruistic instinct. Here belong the extreme individualists, including the anarchists, and the others who say: Why should I govern my actions to meet the expectations of society; what right has society over me, anyway?

(4) Knowledge of the mores, with presence of the social instincts, but with inability to meet the expectations of society through insufficient inhibition or self-control. This insufficiency

may be a general constitutional and permanent one, or it may be temporary (often more or less periodic) due to abnormal internal secretions or other causes. Here belong, among others, the hyperkinetic, the hysterical and epileptoid offenders.

It would seem as though future progress in an understanding of conduct would lie less in a classification of people into the feeble-minded and normal than in a study of the individual's early training, mentality, social instincts and inhibitions.

2. The great body of the work (pp. 47 to 434) consists of the descriptions of 327 cases of feeble-minded individuals, with the family history as far as could be obtained. These are grouped under the heads: hereditary, probably hereditary, neuropathic ancestry, accident, no assignable cause, and unclassified. These pages contain many interesting and significant details.

3. In the third section dealing with "causes," the author properly criticizes much of the *post hoc ergo propter hoc* argumentation which is extremely widespread among medical writers. Goddard's conclusion that about 80 per cent. of the cases of feeble-mindedness with which he deals are hereditary, probably hereditary or neuropathic is interesting; yet from the nature of the case so precise a figure based on materials that in their nature are unprecise must be regarded as a rough judgment and one of which too much may readily be made. In this section is discussed the heredity of "feeble-mindedness" and the conclusion is reached that normal mentality is dominant over feeble-mindedness. Goddard confesses to having been prejudiced against the view "that the intelligence even acts like a unit character. But there seems to be no way to escape the conclusion." Now, since feeble-mindedness is a social and not a biological term, it would seem almost absurd to seek to find a law of its inheritance. The case seems to be this, a large proportion of the feeble-minded are such because of general failure of development of the intellectual centers. A "general intelligence" there well may be, as he concludes; but that does not prevent the hypothesis of special talents (or their lack) and special elements of self-control. Thus, there may well be an hereditary basis for many of the mental differences between persons, whether "normal" or "feeble-minded."

4. The practical applications from Goddard's study he finds in applied eugenical procedures, especially the prevention of propagation of the defective stock. While our efforts to segregate must be increased, sterilization is useful in cases that can not be otherwise reached, and many mental defectives may well be cared for at their homes.

In general, the book shows some haste in composition and the latter is in spots defective, but nevertheless, it will be everywhere regarded as a useful piece of work and one that every one who is concerned with the troubles of human society will prize.

C. B. Davenport

Cold Spring Harbor, N. Y.,
October 31, 1915

Handwörterbuch der Naturwissenschaften. Herausgegeben von Prof. Dr. E. Korschelt, Marburg (Zoologie), Prof. Dr. G. Linck, Jena (Mineralogie und Geologie), Prof. Dr. F. Oltmanns, Freiburg (Botanik), Prof. Dr. K. Schaum, Giessen (Chemie), Prof. Dr. H. Th. Simon, Göttingen (Physik), Prof. Dr. M. Verworn, Bonn (Physiologie), Dr. E. Teichmann, Frankfurt a. M. (Hauptredaktion). Jena, 10 volumes, in 4°, 1912–15. Verlag von Gustav Fischer.

The splendid work issued under the above title and with the editorship indicated is worthy of close inspection from those interested in the various lines of natural science included. The initial lieferungen have already been reviewed by Professor Arthur Gordon Webster[1] in these pages and I do not doubt that now on the completion of the work he will favor us with a discussion from the side of the physical sciences. The desirability of having the attention of workers in the natural sciences directed to the "Handwörterbuch" has led to the writing of this review.

[1] Science, N. S., Vol. XXXVIII., No. 972, pp. 230–233, August 15, 1913.

Professor Webster has already discussed the position of the work among the encyclopedias of the world and has mentioned the excellence of the short biographical sketches, as well as touching on various phases of the biological articles. As suggested by Professor Webster in regard to mathematics, anatomists will be keenly disappointed to find *their* science also neglected, save in the introduction of anatomical work into other branches of natural science; but the "Handwörterbuch" will be found extremely useful in certain lines, none the less. One interesting feature, mentioned by Professor Webster, is the up-to-dateness of the various articles, illustrations from the younger or more recent writers being chosen in preference to time-honored cuts. Perhaps this is partially due to the authors of the individual articles, but it is also evidently the policy of the editors to have the work as complete as possible. The articles are, in general, brief, some of them well illustrated, with the chief sources of literature given at the end.

It has been the privilege of the writer to use this work extensively in a compilation of a biographical nature, and it is a pleasure to say that he has found the "Handwörterbuch" extremely useful. The biographical sketches, of which there are a great many, are short, without illustrations, and give at the close the important sources of information concerning the individual discussed. This feature is very important in a historical study of biology and is a great improvement over the Encyclopedia Britannica, for instance, where sources of reference are mentioned only incidentally. Many names are not included which might justly belong in the work. Mendel is inserted as an afterthought at the close of volume ten. None of the more important human anatomists are included, even those who were engaged in zoological work.

The special articles have been assigned by the editors to prominent scholars in the various lines of work. The recent Amphibia, for instance, are treated in a very complete way by Dr. J. Versluys, in an article covering twenty-five pages. The illustrations might have been better chosen, but they represent the general features of amphibian morphology. The "Paleontology of the Amphibia" is treated by J. F. Pompeckj, a writer well known to students of paleontology. The article, covering nine pages, is well illustrated, the figures being chosen from among the papers of Williston, Dollo, von Meyer, Moodie and Zittel. The same subject is covered much more fully in volume nine, under the heading "Stegocephalen." Friedrich von Huene is the author of this article, which covers seven pages, richly illustrated, with a good list of recent literature at the end. It is rather unfortunate to separate the discussion of Amphibia and Stegocephalia, since the present writer is firmly convinced that they are both members of the same groups; that is, all of them are Amphibia. Other remarks and illustrations regarding the extinct Amphibia are to be found under the various geological periods. Under "Karbonformation" the only figured representative of the rich vertebrate land fauna of the Coal Measures is the much-worn and time-honored figure of *Lepterpeton Dobbsii*, described by Huxley from the Coal Measures of Ireland, but the discussion, by W. Kegel, is well balanced.

Paleontologists will find the work extremely useful, and especially teachers of paleontology will have a work to which their students can refer for a discussion of general topics, which, in general, have been brought well down to date. Some of the articles are especially refreshing in the presentation of new ideas. Gustav Tornier's article on the paleontology of the reptiles, covering forty pages, is an instance of this. The article is very well illustrated; the figures being chosen from papers by Broili, Broom, Newton, Osborn, Fraas, Tornier and Eaton. Tornier's original reconstructions of *Diplodocus* and *Stegosaurus*, have already attracted the attention of paleontologists and have been discussed especially by Matthew. It is rather startling to see our old friend *Triceratops* sprawling on the ground like a horned toad, but such new ideas are worth while in keeping our interests alert. It is most unfortunate that, in a work of this nature, the important researches of Case and

Williston on the Permian reptiles of America should have been entirely ignored. Some of the many, and much worn, illustrations of the Dinosauria might easily have been replaced by excellent illustrations from one or the other of these writers.

The paleontology of fishes is very fully covered by Pompeckj, illustrations and discussions of typical forms of the various groups being chosen. The reconstruction of the Devonian *Paleospondylus* by Sollas, based on serial sections, is given. The restorations and drawings by Patten and Traquair of the early Devonian Placodermi are well shown in many illustrations, as well as such recent figures as Hay's *Edestus crenulatus,* which is one of several early elasmobranchs figured. Many well-known restorations and figures of fish anatomy from the writings of Dean, Dollo and Woodward complete the work.

The general discussion of the recent mammals by W. Kukenthal is followed by a sixty-four page article by O. Abel on the paleontology of the mammals. This latter section is illustrated by 122 figures, which are well chosen, as we would expect from such an eminent student as Abel.

The article on "Zelle und Zellteilung" covering one hundred and seventy pages, richly illustrated with 225 figures, is one of the more extensive biological articles. It is divided into three sections: (1) Zelle und Zellteilung, Botanisch; (2) Zoologisch; and (3) Zellphysiologie. The botanical section is written by E. Kuster, the zoological section by L. Bruel and the physiology by M. Verworn, each section being followed by numerous references to the important literature.

The anatomy and physiology of the sensory organs, covering sixty-five pages, with eighty-one figures and many bibliographic references, deals with special sense organs throughout the whole range of animal life. The discussion and illustration of this immense subject is necessarily brief and specialists will be disappointed to see their favorite subjects but slightly touched or neglected; however, for a work of this character the article will prove helpful.

The work, taken as a whole, contains many interesting contributions to paleontology and zoology. The articles discussed above may be taken as typical of the other articles in the work. A general index of three hundred and sixty pages closes the work. The individual articles show that a high ideal was adopted, which has been well sustained throughout. The volumes are well printed, the illustrations are clear, and in every way the work lives up to the good reputation so long enjoyed by the press of Gustav Fischer.

Roy L. Moodie

Department of Anatomy,
University of Illinois, Chicago,
October 30, 1915

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

The eleventh number of volume 1 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *Experiments on the Development of the Limbs in Amphibia:* Ross G. Harrison, Osborn Zoological Laboratory, Yale University.

At the time of appearance of the tail bud the anterior limb of *Amblystoma* is already determined in the mesoderm cells of that region of the body wall which lies close to the pronephros and ventral to the third, fourth and fifth myotomes. The prospective significance of this group of cells, as a whole, thus is defined some time before differentiation becomes visible.

2. *A Mechanism of Protection against Bacterial Infection:* Carroll G. Bull, Rockefeller Institute for Medical Research, New York.

Bacteria circulating in the blood are quickly removed when they are agglutinated or clumped, and the clumps deposited within the organs are taken up by phagocytes and digested. They appear not to be destroyed by solution or lysis through the operation of serum constituents of the blood.

3. *On the Life-History of Giardia:* Charles Atwood Kofoid and Elizabeth B. Christiansen, Zoological Laboratory, University of California.

Giardia muris and *Giardia microti* produce a readily recognizable enteritis in mice, and both binary and multiple fission take place in the free non-encysted stage—there is no *Octomitus* stage. The morphological characters separate six species. The parasite in mice appears to be distinct from that in man.

4. *The Inorganic Constituents of Alcyonaria:* F. W. Clarke and W. C. Wheeler, United States Geological Survey, Washington.

The stony corals have been repeatedly analyzed, and with generally concordant results. Thirty analyses here made have confirmed the older data. The object of the investigation is to determine what each group of organisms contributes to the formation of marine limestones. The highest proportions of calcium phosphate are commonly associated with high values for magnesia.

5. *An Experimental Analysis of the Origin and Relationship of Blood Corpuscles and the Lining Cells of Vessels:* Charles R. Stockard, Department of Anatomy, Cornell University Medical School.

Vascular endothelium, erythrocytes and leucocytes, although all arise from mesenchyme, are really polyphyletic in origin; that is, each has a different mesenchymal anlage.

Edwin Bidwell Wilson

SPECIAL ARTICLES

INTERFERENCES WITH TWO GRATINGS

If two identical grating are placed with the ruled faces and rulings in parallel and the horizontal and transverse axes of their spectra (of the same side and order) in coincidence, white light passed through them from the collimator of a spectrometer shows intense, nearly equidistant, vertical interference fringes in the telescope. The path difference is subject to the equation $e(1 - \cos\theta)$, where e is the distance apart of the ruled faces and θ the angle of diffraction. These fringes therefore belong to the coarse set which I described elsewhere. Though not exceptionally sensitive to displacements of either grating, they are available throughout a relatively large interval; *i. e.*, e may be increased from coincidence to over 2 cm. As two stretched films suffice, these strong fringes admit of many practical applications.

A more interesting class of fringes may be observed, when the light used in the same instrument is homogeneous. There are three types of these fringes of constant wave-length. The first of these is obtained with the same adjustment for coincident longitudinal and transverse spectrum axes, but needs a wide slit. Obliquity of the incident rays here replaces the above color difference. The second class appears with a fine slit, coincidence of longitudinal axes, but in the absence of coincidence of transverse axes (in which adjustment the fringes would be of infinite size). They are thus evoked by a difference in the angle of incidence at the two gratings, respectively. Frequently they are seen to best advantage with the naked eye or a lens. They increase in size as the eye is withdrawn from the grating; or if seen in the telescope, if the ocular is either pulled out or pushed in from the position for the principal focus where D lines only are seen. For any given position of the eye they do not vary in size while either grating is displaced from coincident position, to the position of vague evanescence, 4 or 5 millimeters beyond. Both this and the following fringe patterns rotate rapidly with the slight rotation of either grating in its own plane.

The third class is obtained in the absence of a collimator and is due to the varying obliquity of diffuse homogeneous light. The longitudinal spectrum axes must coincide, but the transverse axes need not. They are very strong, best seen with the naked eye or lens, but admit of relatively little displacement of either grating, as they vanish with increasing smallness. They usually lie in a definite focal plane, which recedes to infinity as the gratings are more and more separated.

Finally it is interesting to note that phenomena of a somewhat similar kind may be obtained with reversed spectra.

Carl Barus

Brown University,
Providence, R. I.

THE EFFECT OF X-RAY ON THE RESISTANCE TO CANCER IN MICE[1]

It has been shown in previous communications that the resistance to heteroplastic tissue grafts apparently depends on the activity of the lymphocyte. The facts on which this conclusion is based are briefly as follows: The chick embryo, which normally lacks the ability to destroy a heteroplastic tissue graft, if supplied with a bit of adult lymphoid tissue, becomes as resistant as the adult in this respect. Furthermore, an adult animal deprived of the major portion of its lymphoid system by repeated small doses of X-ray, no longer has the power to destroy a graft of foreign tissue, and this tissue will grow actively. The chief characteristic of a failing heteroplastic graft in the unsuitable host is a marked local accumulation of lymphocytes. The histological picture is identical in a failing cancer graft in an immune animal of the same species. Synchronous with the establishment of the cancer immunity and during the period in which the lymphocytes are accumulating around the cancer graft, there is a lymphocytic crisis in the circulating blood. This is found in the actively immunized animals as well as in those possessing a natural immunity, but is totally lacking in animals susceptible to the cancer graft. If the lymphoid crisis be prevented in immune animals by a previous destruction of the lymphoid elements with X-ray the potentially immune animal is changed to a susceptible one.

We have noted that while repeated exposures to X-ray will destroy the lymphoid elements of an animal, one small dose will stimulate these same cells. With this artificial method of producing a lymphocytosis we have attempted to study the relation of this condition to the resistance of mice to their own spontaneous tumors. For evident reasons it was necessary to rule out the complicated question of the direct effect of X-ray on the cancer. In order to do this we have removed the cancer at operation, and with the cancer out the animal has been subjected to a stimulating dose of X-ray. Immediately after this a graft of the original tumor was replaced in the groin of the animal. As a control the same procedure was carried out, but with X-ray treatment omitted. As a further check to the results cancers were removed from a number of animals and in this set the cancers were exposed directly to the same amount of X-ray that the animals in the first group had received. After this a graft of the tumor was returned to the original host.

The results of these three experiments are to be judged by two criteria. First, whether or not there is a return of the disease, either at the site of removal of the cancer, or at the point of inoculation of the returned graft; and second, the time at which the returned graft starts in active growth, if at all. The figures on these points are given in the following table.

	Immune Per Cent.	Susceptible Per Cent.	Local Recurrence of Tumor Per Cent.	Average Time for Appearance of Graft.
Series I . . .	50.0	50.0	21.2	5 wks. and 4 days.
Series II . .	3.4	96.6	48.3	1 wk. and 5 days.
Series III. .	0.0	100.0	40.0	1 wk. and 3 days.

Series I. was composed of 52 animals treated by X-ray while the cancer was outside of the body, with later a return of a graft of the tumor. Series II. was made up of 29 control animals in which the cancer was removed and a graft returned without treatment to either animal or tumor. Series III. was made up of ten animals from which the cancer was removed and the cancer subjected directly to the same amount of X-ray that the animals received in the first series, and later a graft of this X-rayed cancer returned to its original host.

It will be seen from these figures that an X-ray dose which produced a lymphocytosis when administered direct to the animal was sufficient to render 50 per cent. of the mice so treated immune to a returned graft of their

[1] From the Laboratories of The Rockefeller Institute for Medical Research. Abstract of paper presented at the New York meeting of the National Academy of Sciences.

own tumor, and in the other 50 per cent. greatly to retard the return of the disease. A similar dose of X-ray given to the cancer direct outside of the body did not influence the subsequent growth of a graft of this tumor when returned to its original host. The contrast between these figures and those of the control series is striking, as is also the number of local recurrences in the two series. If this pronounced result is obtained with one stimulating dose it is probable that a more pronounced effect might be obtained by a second exposure to X-ray after a suitable interval.

JAMES B. MURPHY,
JOHN J. NORTON

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 543d meeting of the society was held in the Assembly Hall of the Cosmos Club, Saturday, October 23, 1915, called to order by President Bartsch at 8 P.M., with 85 persons present.

Under the heading Brief Notes: Dr. C. W. Stiles recorded observations on blood examinations (cell counts, hemoglobin, etc.) of 600 children, between 6 and 17 years of age, in North Carolina. Dr. Stiles also made remarks on the International List of generic names of birds.

Under heading Exhibition of Specimens: Dr. J. N. Rose showed some interesting examples of humming-birds' nests which he had collected in Brazil the past summer.

The first paper on the regular program was by Professor A. S. Hitchcock, "Collecting Grasses in the Southwest." Professor Hitchcock spoke of his trip during the summer in the region from California to west Texas for the purpose of collecting grasses.

At Grand Canyon was found the rare *Stipa arida* Jones. At Ft. Bragg, Calif., was found *Agrostis breviculmis* Hitchc., known only from this locality and the western coast of South America. It is abundant on the open ground back of the sandy clay cliffs at this point. In a springy place on the side of the cliffs there was a colony of *Phleum alpinum* L., a grass of the high mountains of California. Its occurrence at sea level was very unexpected. At various points in northern California occurs *Danthonia americana* and *D. californica*. In these species the culms disarticulate near the base at maturity. An examination of the swollen base of the detached culms discloses, hidden beneath the sheath and prophyllum, a cleistogamous spikelet consisting of a single floret. The floret and enclosed caryopsis are much larger than those of the panicle.

Cleveland Natural Forest, lying east of San Diego, was visited to investigate *Calamagrostis densa* Vasey. This species known only from the type collection by Orcutt was provisionally united with *C. koelerioides*, by the speaker,[1] but he is now satisfied that the two are distinct species.

An ascent was made of Humphreys Peak of the San Francisco Mountains, near Flagstaff, Arizona. These are the highest mountains in Arizona, the peaks extending above timber line. In the alpine region four species of grasses were found, *Trisetum spicatum, Poa rupicola, Festuca brachyphylla* and *Agropyron scribneri*. Collections were made at several other places of interest: Oracle, about 45 miles north of Tucson, in company with Professor J. J. Thornber; Big Spring, Alpine and Del Rio, in western Texas; and the Guadalupe Mountains of southern New Mexico, especially rich in Mexican species. Professor Hitchcock's paper was discussed by the chair.

The second and last paper of the program was by R. L. Garner, "African Studies; Things in Common Among Men, Apes and Other Mammals." Mr. Garner spoke of the courtship, family life, period of infancy, arrival of puberty, instincts, homes, habits and moral traits of the African anthropoid apes as observed by him in their wild state, during many years of observation in Africa. Among other things he stated that the period of gestation was probably seven months; that the young ape was born with usually 4 teeth present, twin births are exceedingly rare, the female becomes sexually mature at from 7 to 9 years, and the male from 1 to 2 years later, the usual length of life is 20 to 21 years; that their foods are mainly vegetable, but that flesh is an essential part of their diet; that they have no permanent homes, but travel about as nomadic families; that their sleeping position is on their back or side like that of men, they often make their beds 18 to 25 feet off the ground, but the young are delivered in a bed on the ground in a well-drained place; that sight and particularly hearing are acute, but that smell is not much more developed than in man and touch is less acute than in man; that the right of ownership among them is well respected. Mr. Garner concluded by saying he

[1] In Jepson, "Flora of California," 3: 125. 1912.

hoped to return to Africa in the near future and take motion pictures of the great apes.

The society adjourned at 10.10 P.M.

M. W. LYON, JR.,
Recording Secretary

THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and seventy-eighth regular meeting of the society was held at Columbia University on Saturday, October 30, 1915. Fifty-one members attended the two sessions. President E. W. Brown occupied the chair. The council announced the election of the following persons to membership in the society: Mr. D. R. Belcher, Columbia University; Professor J. W. Calhoun, University of Texas; Professor Sarah E. Cronin, State University of Iowa; Mr. C. E. Epperson, Kirksville Normal School, Mo.; Dr. Olive C. Hazlett, Radcliffe College; Mr. C. M. Hebbert, University of Illinois; Miss Goldie P. Horton, University of Texas; Professor W. S. Lake, School of Mines and Industries, Bendigo, Australia; Mr. D. H. Leavens, College of Yale in China; Mr. C. T. Levy, University of California; Dr. F. W. Reed, University of Illinois; Professor L. H. Rice, Syracuse University; Mr. J. F. Ritt, Columbia University; Professor D. M. Y. Sommerville, Victoria University College, Wellington, N. Z.; Miss Leila R. Stoughton, Rosemary Hall School, Greenwich, Conn.; Dr. C. E. Wilder, Pennsylvania State College; Mr. A. R. Williams, University of California; Dr. L. T. Wilson, University of Illinois; Dr. F. E. Wright, U. S. Geological Survey. Four applications for membership in the society were received.

A list of nominations for officers and other members of the council to be elected at the annual meeting was prepared for the official ballot for the annual election. A committee was appointed to audit the accounts of the treasurer for the current year.

Twenty members were present at the dinner arranged for the evening, always one of the most pleasant features of the meetings.

The twenty-third summer meeting of the society will be held at Harvard University early in September, 1916. At the seventh colloquium of the society, held in connection with this meeting, courses of lectures will be given as follows: By Professor G. C. Evans, "Topics from the theory and applications of functionals, including integral equations." By Professor Oswald Veblen, "Analysis situs."

The following papers were read at the October meeting:

G. A. Pfeiffer: "Existence of divergent solutions of the functional equations $\phi[g(x)]=a\phi(x)$, $f[f(x)]=g(x)$, where $g(x)$ is a given analytic function, in the irrational case."

C. N. Haskins: "On the extremes of bounded summable functions and the distribution of their functional values."

G. M. Green: "Projective differential geometry of one-parameter families of space curves, and conjugate nets on a curved surface. Second memoir."

G. M. Green: "The linear dependence of functions of several variables."

A. R. Schweitzer: "On the dependence of algebraic equations upon quasi-transitiveness."

H. S. Carslaw: "A trigonometrical sum and the Gibbs phenomenon in Fourier series."

W. F. Osgood: "On a sufficient condition for a non-essential singularity of a function of several complex variables."

Dunham Jackson: "Singular points of functions of several complex variables."

W. F. Osgood: "On functions of several complex variables."

L. P. Eisenhart: "Envelopes of rolling and transformations of Ribaucour."

W. B. Fite: "Note on homogeneous linear differential equations of the second order."

H. S. Vandiver: "Note on the distribution of quadratic residues."

G. D. Birkhoff: "A theorem concerning the singular points of ordinary linear differential equations."

H. S. White: "Closed systems of sevens in a 3-3 correspondence."

W. R. Longley: "Note on a theorem on envelopes."

A. R. Schweitzer: "On the dependence of algebraic equations upon quasi-transitiveness. Second paper."

A. R. Schweitzer: "A new functional characterization of the arithmetic mean."

The San Francisco section of the society held its twenty-seventh regular meeting at Stanford University on November 20. The Southwestern section held its ninth regular meeting at Washington University, St. Louis, on November 27. The annual meeting of the society will be held at Columbia University on Monday and Tuesday, December 27–28. The Chicago section will meet at Columbus, Ohio, in affiliation with the American Association for the Advancement of Science on December 30–31 and January 1.

F. N. COLE,
Secretary

SCIENCE

FRIDAY, DECEMBER 17, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

RECENT RESEARCHES IN THE WOLCOTT GIBBS MEMORIAL LABORATORY OF HARVARD UNIVERSITY[1]

THE Wolcott Gibbs Memorial Laboratory of Harvard University is one of the most significant monuments ever built in memory of a chemical investigator. So far as I know, only the Davy-Faraday Laboratory in London, the van't Hoff Laboratory in Utrecht, and the Hofmann Haus in Berlin equal it in importance. Because Professor Wolcott Gibbs was one of the founders and presidents of the National Academy of Sciences, an account of the memorial building and of its first fruits is especially appropriate here to-day.

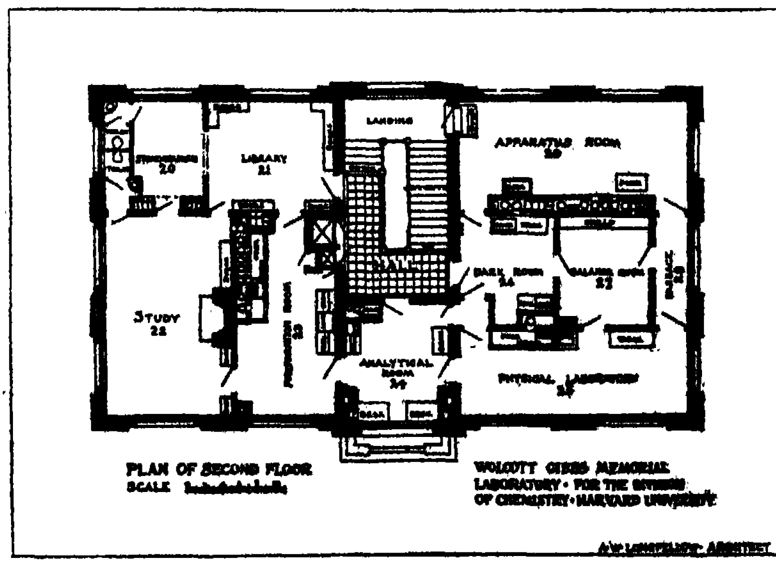
The new laboratory was initiated by the late Dr. Morris Loeb, the devoted and able pupil of Gibbs. He and his brother, James Loeb, subscribed $50,000, provided that other friends of Harvard University should raise $50,000 more. With admirable feeling, Dr. Loeb especially desired that the building should be named in honor of his former teacher and friend. In March, 1910, Dr. Alexander Forbes and other generous donors having greatly helped, the fund was completed; and in January, 1913, the building was opened for work, so that it has now been almost three years in full activity.

It is a great pleasure to express here the very lively gratitude, both on behalf of the university and on my own account, which I feel for the liberal interest of all these benefactors in the construction of this building.

Being the first of a large group of chem-

[1] Address delivered at the meeting of the National Academy of Sciences in New York, November 16, 1915.

ical laboratories planned for the department of chemistry at Harvard University, it was designed with especial care. Red "Harvard" brick with Indiana limestone trimmings, and Deer Isle granite foundations, constitute its external dress; the architectural details, due to A. W. Longfellow, are simple, effective and in good taste. It covers an area of 71 by 41 feet, and is 48 feet high. The construction is extremely solid and substantial, so that it is unusually free from vibration. Within, it is built of brick and reenforced concrete; and although there is some woodwork in doors and furniture, the building is practically incombustible. Hollow bricks and doubly glazed windows with tight weather-strips protect it from heat and cold, and the temperature of almost every room is automatically regulated. The ventilating plant provides filtered air, hence the building is extraordinarily free from dust throughout. Because the laboratory was designed and is used wholly for research, it contains no lecture room, but is divided into many rather small rooms of different sizes, intended for one, two or more investigators, according to the character of the work. There are many balance rooms, dark rooms and other necessities for accurate chemical experimentation, as well as rooms designed for both chemical and physical laboratories, because the work to be done lies on the border-line between chemistry and physics. Pipes are laid for hot and cold water, distilled water, steam, compressed air, oxygen and vacuum, as well as for gas; and electricity of many voltages is available at suitable plugs



throughout. An automatic electric lift is used for transferring the apparatus, and telephones connect all the important rooms. The building has six floors available for work: three regular stories, a very light and convenient basement, a sub-basement for especially constant temperature work entirely underground, and a practicable roof. Perhaps the most important feature in its design is the arrangement of the balance rooms, dark rooms and laboratories in suites, so planned as to give the greatest possible usefulness to each, in the manner illustrated by the right-hand side of the

plan of the second floor. The arrangement is similar, not only on both ends of the third floor, but on the western end of the ground floor. Rooms are provided in the basement for the storage and handling of apparatus, a workshop, storage batteries, switchboards and other purposes. But a complete description of this laboratory and of its virtues would take far too much time for the present occasion.[2] It is enough to say that the three years' work in it have shown it to be ideally adapted to the sort of investigation for which it had been planned.

In the front hall stands a bronze bust of Wolcott Gibbs with a marble tablet bearing the inscription:

WOLCOTT GIBBS
FEB 21 1822–DEC 9 1908
RUMFORD PROFESSOR
HARVARD UNIVERSITY
1863–1887 EMERITUS 1887–1908
PATHFINDER IN AMERICAN CHEMISTRY

With the building came a fund bearing an income sufficient for heating and janitor service, but not enough to purchase any suitable amount of special apparatus. Therefore, the subsidies which the director has received from the Carnegie Institution of Washington have been of very great use in providing part of the equipment of scientific apparatus and additional expert assistance. Indeed, without such help but little could have been done. I take great pleasure, therefore, in expressing my indebtedness to this institution, and feel that it shares with Harvard University and the generous founders in any credit which may be attached to the output of the laboratory. Also to the able assistants and advanced students who have helped me with so much patience and enthusiasm, I am deeply grateful. Twenty-four in number, they have been, of course, chiefly Americans (by no means all Harvard men), but the list includes four Canadians, an Icelander, a Dane, a Japanese, and a German. Moreover, the laboratory now harbors two guests, one conducting a research on the chemical activity of radium emanations and the other on the acidity of sea water. These two investigators are collaborating with colleagues who have no such suitable place elsewhere to offer for the investigations. Concerning these researches, however, it is not my province to speak.

What now has been the first fruit of this building? For the architectural shell is only a means, not an end in itself; and except as a memorial its existence is justified only by the work accomplished within it. During the past three years 24 papers have been published from this laboratory, and a number of other investigations have been almost finished and are being prepared for publication. Their character varies widely, ranging from almost pure chemistry to almost pure physics, but, in spite of the diversity, there is, for the most part, a common aim underlying them all. This aim is a careful study of the fundamental properties of the chemical elements—those substances which constitute the basis of our visible and tangible universe. Among these fundamental properties may be mentioned their atomic weights, their densities and compressibilities, their electromotive behavior and heat of combination with other elements and, finally, the physical and chemical properties of their simple compounds. Let us consider briefly the several investigations already published and now in progress.

Turning, first, to the study of atomic weights, three investigations on this subject have already yielded publications. The first of these was a research upon the atomic weight of carbon, in which sodium carbonate was prepared in an unusual degree of

[2] A fuller description of the laboratory was published in the *Harvard Alumni Bulletin* for March 26, 1913.

purity and converted into sodium bromide, the amount of silver necessary to precipitate the combined bromine being determined. In this way the relation between the atomic weights of bromine and carbon was determined, and the agreement of the values thus found with the parallel work of others gives very satisfactory evidence of the trustworthiness of all the other atomic weights which have been determined at Harvard in relation to bromine. Next came the study of the atomic weight of sulphur, which was studied in somewhat similar fashion, pure sodium carbonate being converted into pure sodium sulphate, and thus the relation between carbon and sulphur found through those salts. The value of sulphur obtained in this way was somewhat less than that ordinarily accepted, but not more than might reasonably be ascribed to the possible errors of previous work. On the whole, these two investigations, in which the purest sodium carbonate formed the starting point, add distinctly to one's confidence in the present accepted table of atomic weights. Both of these investigations were so extremely delicate and so very dependent upon pure, dust-free air that they could hardly have been executed at all in a less perfect building.

Next, during 1913–14 the atomic weight of lead from radioactive sources was studied; and we found that this sort of lead has an atomic weight distinctly lower than ordinary lead, although no known impurity could be found in it, and although its ultra-violet spectrum is identical with that of ordinary lead. This work was soon supported by independent and almost simultaneous but less complete and searching investigations published in Austria and France; and later has been reenforced by continued research in both continents. The outcome has unusual interest and significance, because it seems to indicate that there may be different kinds of lead having many properties precisely similar, but differing as to their atomic weights. The research is being continued at the Wolcott Gibbs Memorial Laboratory, large amounts of radioactive lead having been obtained from Australia, Colorado and Norway through the kindness of scientific friends.

Whatever may be the final outcome, one can not help thinking that researches of this kind deal with mysteries which are among the most fundamental of all those presented to the physical chemist, for the nature of the chemical elements underlies all the mechanism upon which life depends.

The study of compressibility was continued in two directions—on the one hand, the behavior under pressure of similar organic substances, and on the other hand, the compressibility of the elements, being carefully studied with increasing accuracy and effectiveness. This seems rather a strange subject to pursue in a chemical laboratory; but its interest is truly chemical, because of its relation to the recent theory of atomic compressibility, which gives a new interpretation of the mechanism of chemical action. There is not time to expound this theory at length here, but those who desire acquaintance with it will find a fairly complete résumé in the number of the *Journal of the American Chemical Society* for last December.[3] Suffice it to say that many facts may be interpreted to mean that the atoms are not hard, incompressible particles, but rather elastic, compressible, deformable entities, capable of yielding somewhat to every source of pressure which may be applied upon them. Moreover, evidence is available showing that both chemical affinity and cohesion exert pressure in their action, and hence affect the space

[3] *Jour. Am. Chem. Soc.*, 36, 2417–2439 (1914). Many references to other papers on this topic are given in the accompanying bibliography.

occupied by the atoms. In the interpretation of all the facts, knowledge of the compressibility of elements and compounds is essential; and as the available data are scarce, work in this direction was prosecuted with vigor. It is enough to say that the compressibility of over a score of organic substances and of nine elements (namely, tungsten, molybdenum, tantalum, boron, copper, iron, lead, thallium and mercury) have been determined during the last three years, either for the first time or at least with more accuracy than ever before. The apparatus for this purpose has been studied with a view to the detection of all the insidious minor errors which may affect work of this kind, and has been distinctly improved in several ways. Some of the theoretical outcomes of this work, which shows that the compressibilities of the elements are periodic, like their atomic volumes, have been briefly expounded in the July number of the new *Proceedings* of this academy. Here it is shown that the compressibility of the elements seems to depend in a large degree upon the atomic volumes and melting points of the several elements.

A revision of thermochemical data, which has been in progress for a number of years, has been especially advanced during the last three years in the Wolcott Gibbs Memorial Laboratory. The method of protecting a calorimeter from accidental heating or cooling, by always keeping the jacket around it at just the same temperature as the calorimeter itself, has been found efficient and convenient. Automatic contrivances called "synthermal regulators" for maintaining this identity of the two temperatures have been devised, and in various details the calorimetric procedure has been perfected. This method, by the way, which as applied to calorimeters of changing temperatures took its origin at Harvard, is spreading rapidly over the world, and has now adherents not only in various parts of America, but even so far away as Moscow.

The heat given out by the combustion of many organic substances has been studied, especial emphasis having been laid upon the danger of incompletely burning the more volatile compounds, which evaporate too quickly to be burned all at once; and precautions have been perfected for preventing this error. In addition, methods for determining the heat evolved during the solution of metals in acids, the neutralization of acids and alkalies, as well as for finding the specific heats of solutions—data which form the basis of all the thermochemistry of metallic salts—have been improved and amplified. In connection with these researches upon the heat evolved in chemical action, a study of methods of calibrating thermometers, of determining fixed points upon them by the transition temperatures of pure salts, and of subdividing the intervals between the fixed points in various ways so as to correspond exactly to the true temperature scale, has been carefully conducted. Also, considerable time was spent upon the further investigation of floating equilibrium—the point at which a sunken sealed float of fixed volume neither rises nor sinks in a liquid. The effect of concentration of various solutions on the temperature of this equilibrium was studied, as well as the slight volume changes suffered by the float with time, temperature and pressure. It has been shown that with due care this phenomenon may be used for either analyzing solutions or standardizing thermometers.

An interesting physico-chemical problem connected with the study of transition temperatures is the effect upon the crystalline "melting points" of impurities which crystallize out with deposited salts. In par-

ticular, the effect of sodium sulphate on the "melting point" of hydrated sodium chromate, and the effect of strontium bromide on strontium chloride, were both carefully studied.

Another investigation allied both to that just mentioned and to the work on compressibility, is the effect of pressure upon the solubility of salts. Theoretically as well as experimentally this is not a new subject, but there is still great need for the procuring of accurate data. A small but practicable apparatus was devised, making possible the determination of this effect as far as 600 atmospheres pressure, and preliminary results have already been obtained upon a number of typical salts. These investigations also are still being continued.

Turning now to the electrochemical side of our activities: during the past three years we have studied anew the precautions necessary in order to determine exactly the weight of silver deposited from its solutions by the galvanic current—a problem which has a distinctly practical bearing, in that the weight of deposited silver is one of the most satisfactory measures of the quantity of electricity flowing through the solution. There can be little doubt that this weight is in precise accord with the demands of Faraday's law of electrolysis, that is to say, is directly dependent upon the atomic weight of silver; but disturbing circumstances enter into the actual determination and one of the most important outcomes of this work was to show once more that the silver under some circumstances may carry down with it appreciable amounts of the solution from which it was deposited, thus increasing its apparent weight and leading to a somewhat erroneous estimate of the relation between quantity of electricity and quantity of substance. This investigation is being continued not only at this laboratory, but also at the Bureau of Standards and at Princeton University.

The electromotive forces manifested by metals and amalgams in appropriate solutions have a significant bearing on the energetic side of chemistry, being concerned not only with the important effect of concentration on chemical change, but also with chemical affinity itself. On this account these electromotive forces have not been neglected in the Gibbs Laboratory, the behavior of concentrated thallium amalgams and alloys of sodium and lead having received attention. The interesting details of these experimental researches are too technical and too elaborate for a brief statement of this kind.

Yet another electrical phenomenon investigated was the dielectric behavior of non-conducting organic substances. The dielectric constants of nearly a score of very pure organic substances were determined by means of a modification of a standard method, which was improved and made much more sensitive and accurate.

In keeping with the plan to study and compare all the important physical properties of typical chemical substances, the densities, melting points and boiling points of many substances mentioned above, which had been purified with very great care, were determined, taking pains about accuracy in the thermometric measurements not usual in chemical laboratories. It is especially interesting, in view of the difficulty of complete purification, to have all these various properties determined on the same uniformly pure samples of material, so that the true correlation between the different properties can be discovered; for, obviously, if one sample containing one set of impurities is used for determining density, and another sample with another set of impurities is used for determining the boiling point, any relation which may

exist between these two properties may be quite obscured by the different impurities. This is what generally happens when different people study the properties of varying samples.

One of the most recently undertaken of all these investigations is the study of surface tension of these same organic liquids. Surface tension, as you well know, is that tendency (caused doubtless by the cohesion of the molecules of substance) which forces any liquid surface to contract as much as possible, thus making drops and bubbles spherical, and drawing liquids up in capillary tubes. Surface tension is of peculiar interest in relation to the theory of compressible atoms, because it gives another clue to the cohesive forces holding matter together in the liquid and solid condition; but the published data even for such a common substance as water vary widely, often as much as 10 per cent. Hence the more careful study of this important property formed a legitimate part of the scheme of investigation for which the Wolcott Gibbs Memorial Laboratory was planned. In the first year of this research, which is being continued at the present time, we were able to find most of the important causes of the serious divergences in earlier work. Many of the experimenters had immersed their capillary tubes (in which the effect was to be measured) in other tubes much too narrow for the purpose, not realizing that even a tube one inch in diameter causes an appreciable "capillary" rise of the liquid contained within it. Again, they failed to allow for optical imperfections in the glass of the tubes containing the liquid, their methods of measurement were sometimes inadequate, and the mathematical formulæ used for calculating the results were often faulty. Therefore, in our preliminary work, which was reviewed briefly in the July number of the *Proceedings* of this academy, it is hoped that a distinct advance has been made.

If high quality had not been sought, of course the number of investigations could have been much greater. Some one has wisely said that the output of physico-chemical work is inversely proportional to the square of the grade of accuracy desired. In the brief space of these few minutes it has been impossible to give much more than a mere list. Those of you who are specially interested will find many of the researches already published in full; brief accounts of others are in the Year Books of the Carnegie Institution of Washington, and before long it is hoped that the rest also may be printed.

An investigator for whom much has been done feels gravely the responsibility which rests upon him of doing much in return; and although in this case he feels the necessary human inadequacy and incompleteness of the work just described, nevertheless he hopes that at least a beginning of accomplishment has been made, and that in the future the Wolcott Gibbs Memorial Laboratory, through many years, will yield ever increasingly useful additions to the sum of human knowledge.

THEODORE W. RICHARDS
HARVARD UNIVERSITY

THE LIFE OF RADIUM

THE life of radium, or the length of time required for a given quantity of radium to be transformed and converted into other elements, is a physical magnitude of considerable importance and interest. Its chief significance lies perhaps within the special field of radioactivity where radium occupies a unique position in being the only highly radioactive radio-element which possesses physical and chemical properties, and occurs in a sufficiently high state of

concentration, to permit its being obtained in reasonable quantities in an isolated and purified condition. For this reason radium is considered and accepted as a standard or typical radioactive substance, and its physical and chemical properties, including the value of its atomic weight, are known with a considerable degree of precision. For some time in the future, therefore, radium will occupy this position of relative importance and will serve as the basis for calculation and comparison with other radio-elements possessing less striking chemical individuality.

An accurate knowledge of the life of radium is also important in the field of geology, because of a method which is available for estimating the geological antiquity of some of the older rocks and minerals. This method is dependent on the determination of the progress of the radioactive disintegration which has taken place in those minerals containing appreciable proportions of uranium. For the accurate calculation of these important magnitudes an exact knowledge of the rate of disintegration of radium is essential.

It is possible, moreover, to obtain an estimate of the probable life of radium by a calculation involving as its basis a number of other important physical constants. These constants will be referred to more specifically later. If a knowledge of the life of radium can be arrived at by experimental methods not directly involving these constants, then, if the results given by the different methods are in good agreement, there is good reason for assuming that the accepted values for these constants are not very different from the true values.

The disintegration of radioactive substances is of such a character that the transformation of the substance into other elements can be expressed by a law in which the rate of transformation is an exponential function of the time. The rate of transformation is independent of the amount of material undergoing disintegration and is independent of the temperature, the pressure or of any other external condition to which we can subject the radioactive substance. It proceeds in such a manner that if half of the material present is transformed in a given period of time, half the remaining quantity will be transformed in a subsequent time of equal duration, and half the amount still left will undergo change in the third equal interval. This will continue indefinitely until the amount remaining will be too small to merit consideration. Since under these conditions some of the atoms of the radio-element will have an inappreciably short life, while others will have an inconceivably long one, it is impossible to attach any special significance to the term "life of" a radio-element except under certain definite restrictions. The life of a radio-element may therefore be somewhat dogmatically expressed in terms of the time required for exactly one half of it to be transformed into other substances. This constant is known as its "half-value period," and it is the half-value period of radium which particularly concerns us at the present moment.

The first estimate of the probable life of radium was published by Sir Ernest Rutherford in the first edition of his textbook "Radio-activity (Cambridge, 1904). In the disintegration theory proposed by Rutherford and Soddy the assumption was made that the expulsion of α-particles by radium and other radio-active substances was coincident with the changes taking place on the disruption of the atoms, namely, that the appearance of the α-particles was indicative of the simultaneous breaking up of the atoms of the radio-element. Rutherford further postulated the theory that each α-particle had its

origin in the disintegration of a single atom, or in other words, that each changing atom gave rise to a single α-particle. If this assumption were correct, then an estimate of the total number of α-particles emitted by any radioactive substance would afford a basis for judging as to the number of atoms which underwent transformation in any given period. From the results of experiments by Wien on the number of β-particles projected from one gram of radium bromide, and from considerations based on the ionization produced in a gas by the α-particles emitted by a known quantity of radium, Rutherford reached the conclusion that one gram of pure radium element expelled 2.5×10^{10} α-particles per second. From data based on experimental evidence it was assumed that the number of molecules in one cubic centimeter of hydrogen at standard pressure and temperature was 3.6×10^{19}. Taking the atomic weight of radium as 225 it was then calculated that there were 1.8×10^{21} atoms in 1 gram of radium.[1]

If the total number of atoms present was 1.8×10^{21} and the number transformed per second was 2.5×10^{10}, then the fraction of the whole undergoing change per second would be 1.4×10^{-11}, and per year 4.4×10^{-4}. This indicated that the half-value period of radium was about 1,500 years.[2]

Another estimate of the life of radium was made by Rutherford in the Bakerian lecture delivered before the Royal Society in May, 1904. Assuming that the heating effect, which had been observed and measured by P. Curie in radium salts, was due to the bombardment of the salt by the α-particles emitted from the radium which it contained and concluding that heat energy which appeared was derived from the kinetic energy of the moving α-particles, Rutherford calculated the kinetic energy of a single α-particle on the basis of the data then available. This he found to be 6×10^{-6} erg per second. The heating effect of about 100 gram calories per hour observed for one gram of radium corresponded to 1.2×10^{6} erg per second. Considering the radium salt as containing four α-ray products (Ra, Ra Em, Ra A and Ra C) and assuming an equal distribution of the heating effect between these, it therefore appeared that the number of α-particles expelled per second per gram of radium itself (and therefore the number of atoms of radium breaking up per second) was 5×10^{10}. Applying the same line of reasoning as had been used in the first instance for deriving the number of atoms in one gram of radium, Rutherford obtained the value of 800 years for the half-value period of radium.[3]

In the year 1905 Rutherford[4] performed an experiment in which the electrical charge carried by the α-particles from a known quantity of radium was measured. This was found to be equivalent to 4.07×10^{-9} ampere per second for the particles emitted by one gram of radium. Assuming the charge on each particle to be the same in value but opposite in sign to the charge carried by a single electron; viz., 1.13×10^{-19} coulomb, this gave the number of α-particles per second from one gram of radium as 6.2×10^{10}. Estimating, in this case without the previous error, the number of atoms in one gram of radium as 3.6×10^{21}, the value obtained for the rate of change of radium corresponds to a half-value period of about 1,300 years.

A new and more accurate determination

[1] An error was made in this calculation, and the correct number based on the data used should have been 3.6×10^{21}. This would have given 3,000 years for the half-value period.

[2] See preceding footnote.

[3] The error mentioned previously was repeated here, and the correct value given by this calculation is not 800, but 1,600 years.

[4] *Phil. Mag.*, 10, p. 193.

of the deflection of the α-particles from radium in a magnetic and an electric field was made in 1906 by Rutherford.[5] This gave a value of 5.1×10^3 for the ratio of the charge to the mass (e/m) of an α-particle. Since the value of e/m for the hydrogen ion in the electrolysis of water is nearly 10^4, Rutherford decided that of a number of possible explanations of these two differing values, the most probable one was that the α-particle consisted of an atom of the element helium (atomic weight 4) with a charge twice that of the electron. If this assumption is introduced into the last previously considered calculation of the life of radium, the number for the half-value period comes out 2,600 years instead of 1,300 years.

In 1908 Rutherford and Geiger[6] devised an experiment in which the actual number of α-particles emitted by a known quantity of radium could be accurately counted. They also accurately measured the charge carried by a known number of these particles, and demonstrated the correctness of Rutherford's earlier assumption that the charge on a single particle was twice that carried by a single electron. From the counting experiments it was evident that the number of α-particles emitted per second from one gram of radium was 3.57×10^{10}. The results of these experiments also gave data from which a more accurate estimate could be made of the number of atoms in one gram of hydrogen, viz., 6.2×10^{23}. Using the numbers thus derived the magnitude of the half-value period of radium was again calculated and found to be 1,690 years.

A direct determination of the rate of disintegration of radium by measurements of the decrease in radioactivity of a given radium salt is not practicable from an experimental standpoint. The rate of disintegration is so relatively slow and the experimental difficulties of accurately measuring the very small yearly decrease in the amount of radium present are so insurmountable that this method of attacking the problem is practically excluded. There is, however, a way in which a knowledge of the life of radium can be obtained which depends upon very different principles from those involved in calculations employed by Rutherford. This method was first suggested and applied by the writer, and its general principles can be briefly described as follows:

The work of Boltwood, McCoy and others has conclusively demonstrated that radium is a transition product in the radioactive disintegration of the element uranium. The sources of radium consist solely of old minerals containing uranium. In these natural compounds the uranium has been undergoing transformation for long periods of time and the products of its disintegration have been accumulating and have been retained in association with the unchanged uranium in the mineral. Now the nature of the successive changes occurring in radioactive substances is such that, in any system such as that represented by a uranium mineral, after sufficient time has elapsed a comparatively simple relation will exist between the quantities of the different genetically connected elements present. The condition finally attained is known as a state of radioactive equilibrium. In this state a simple expression will define the relative amounts of the different, related radio-elements contained in the mineral, and, what is more important to our immediate interests, a very simple relation will exist between the amounts of the different radio-elements undergoing transformation in equal periods of time.

The rate of change of a radio-element is,

[5] *Phil. Mag.*, 11, p. 348.

[6] *Proceedings of the Royal Society*, A, 81, p. 141; *ibid.*, A, 81, p. 162.

so far as our knowledge extends, an unalterable and unvarying factor. It may be defined in terms of the fraction of the whole amount of the element present which undergoes transformation in any convenient unit of time, a year for example. This factor is called the constant of disintegration of the radio-element. Its character is such that if P represents the number of atoms of a radio-element initially present, e is the base of the natural system of logarithms, t is the time expressed in the chosen units, and λ is the disintegration constant; then the number of atoms, P_t, of the element which will remain unchanged after the expiration of an interval t units from the start will be expressed by

$$P_t = Pe^{-\lambda t}.$$

Now, in any radioactive system comprising a parent substance like uranium and a series of disintegration products, including radium, for example, when a state of radioactive equilibrium has been established the conditions will be such that the number of atoms of each of the radio-elements in the series which undergo change in a given interval will be the same and equal. Thus if U be the number of atoms of uranium and λ_1 be its constant of change, and if Ra be the number of atoms of radium with a constant of change λ_2, then $\lambda_1 U = \lambda_2 Ra$, and this will also equal the product of the *number of atoms* of any other radio-element in the series multiplied by *its* disintegration constant. It should be evident from these considerations that the quantity (number of atoms) of radium formed in any given interval will be equal to the quantity (number of atoms) of radium which is transformed in the same interval, an essential requirement to the postulated condition of equilibrium. If, then, we can determine by experiment the quantity of radium which is formed in such a system, we obtain through this a direct measure of the quantity of radium which has changed to other elements during the observed period, and if we know the amount of radium present in the system we can determine the ratio of the two amounts which will be the disintegration constant of the radium. If radium were formed directly from uranium it would be easily possible to separate the uranium from a quantity of mineral containing a known amount of radium, purify it from all but traces of radium, allow it to remain until measurable amounts of radium had been produced within it, and then compare the radium formed from the uranium with the radium present initially in the mineral. This was attempted, but it was found that the rate of production of radium was too slow to be determined with any accuracy and was far less than was to be expected from theoretical considerations. This obstacle was overcome when in 1907 the writer was able to separate from uranium minerals a previously unidentified radio-element which was intermediate between uranium and radium in the series of atomic transformations, and which by its own disintegration produced radium in readily measurable quantities. To this element the name "ionium" was given. It thus became possible to separate the ionium from a mineral containing a known amount of radium, and to determine the rate of growth of radium in this ionium. This is a measure of the rate of production of radium in the mineral and therefore a measure of the rate of disintegration of the radium.

The two diagrams (Figs. 1 and 2) will perhaps be useful in making the general conditions and method of procedure more easily understood to those without a technical knowledge of the subject. In the first (Fig. 1) the amount of uranium changing per year relative to the total

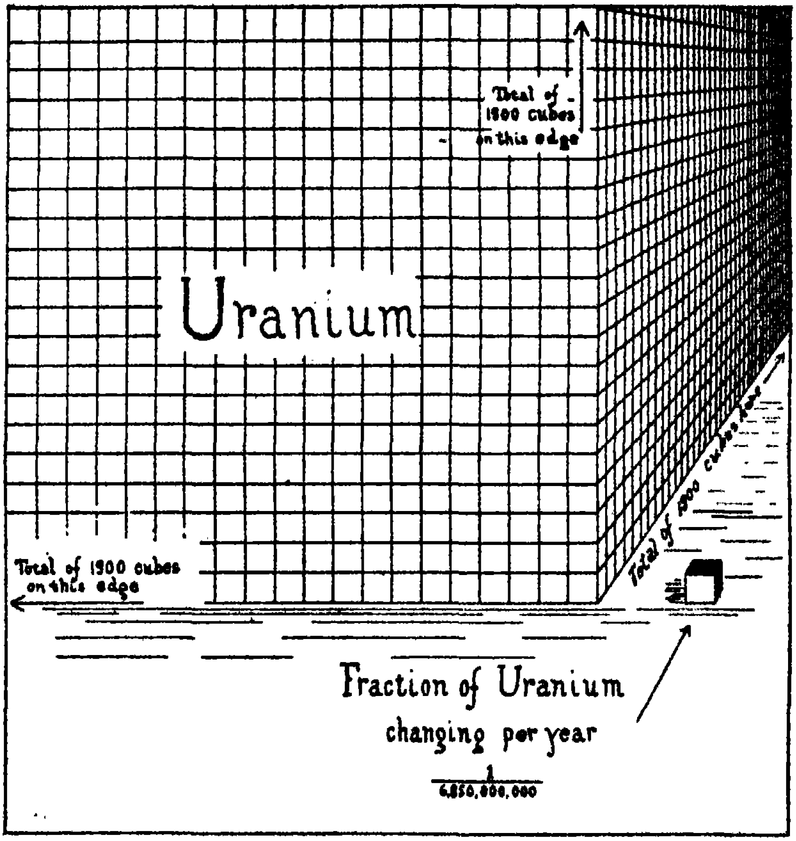


FIG. 1.

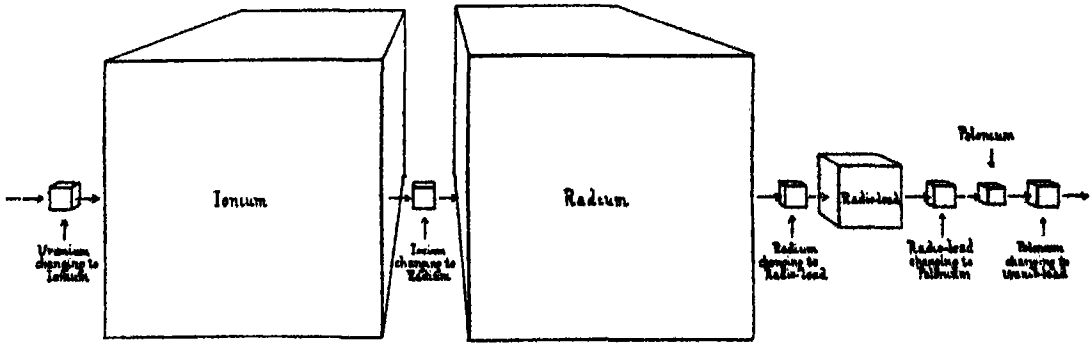


FIG. 2.

amount present is shown by two cubes whose volumes are proportional to the number of atoms involved in the transformation. In the second diagram (Fig. 2) the first cube on the left is supposed to be of the same size as the smaller cube in the first figure. Since the constant of change of ionium is as yet undetermined, it has been assumed for convenience to be approximately the same as that of radium, and the amount of ionium in the mineral is therefore indicated as of the same order as the amount of radium. With this limitation, and omitting the slight complications in-

volved by the existence of branch products, like actinium, and products of a rapid rate of change, like the emanation and radium-A, the diagrams represent the general conditions and changes to be found in an old[7] uranium mineral. The chief relation of interest shown by the diagram is that since the radium changing to radio-lead can not be determined experimentally with sufficient exactness, it is equally satisfactory and very much simpler to determine the ionium changing to radium and compare its quantity with the total amount of radium in the mineral. As a matter of fact the actual amounts of radium involved in these two quantities need not be known, it is only their relative values which are required, since the value of the disintegration constant is determined by the ratio of one of these to the other. In this respect the method is independent of any standard of purity of radium preparations, an advantage which is not possessed by other methods which have been used for attacking the problem. Thus, for example, the estimate of the half-value period of radium made by Rutherford and Geiger as a result of their experiments in 1908, had to be altered from 1,760 years to 1,690 years, when in 1912 the present international radium standard was adopted.

The results of a number of experiments conducted by the writer according to the method just outlined were published in 1908. In the most satisfactory of these experiments the mineral taken was a quantity of pure, primary North Carolina uraninite. almost free from secondary alteration products. About 40 grams of this material were used and the ionium was separated (with the thorium, which has identical chemical properties) by the ordinary analytical methods for the separation of thorium. The growth of radium in this preparation of ionium was then measured over a period of 147 days, and a rate of change for radium corresponding to a half-value period of 1,990 years was obtained. The results of the other experiments were in fair agreement with this value, which was assumed to be the most probable one. It is interesting to point out that this estimate was made between the time of Rutherford's estimate of 2,600 years and Rutherford and Geiger's estimate of 1,760 years.

In view of the disagreement of the value obtained by the "growing" experiment with the value as calculated from Rutherford and Geiger's work, it was reasonable to suspect that in the "growing" experiments all of the ionium was not separated from the mineral. Such a suggestion was, in fact, made subsequently by Rutherford. A careful investigation of some of the conditions associated with the usual methods employed for the chemical separation of small proportions of thorium from large amounts of uranium, indicated that a complete separation of the thorium under such conditions was extremely uncertain if not altogether impossible. The chemical behavior of uranium and thorium are strikingly similar: in the case of the uranous (UO_2) salts the chemical analogy of the two elements is such a close one as to make any separation at all almost impossible. Since an incomplete separation of the ionium would lead to *too small* a production of radium in the growing experiments, under the assumption that the separation was complete the calculated half-value period of radium would receive too high a value. It was therefore highly desirable that the experiments should be repeated under conditions which would avoid any uncertainty, and which would give an altogether trustworthy value for the life of radium as determined by this method.

[7] There are well-known examples of minerals too young for a state of equilibrium to have yet been reached between their radioactive constituents.

This work was undertaken in the university year 1913–14 in my laboratory by Miss Ellen Gleditsch, who came to this country from Norway for a year of study on a fellowship of the American Scandinavian Foundation. The work has been carried out in a very satisfactory manner and, after encountering a number of difficulties, she has quite recently completed her experiments at the University of Kristiania. A paper by her on the subject will appear in the January number of the *American Journal of Science*.

Miss Gleditsch carried out four separate operations, which may be briefly described as follows:

The *first* was with a specimen of very pure North Carolina uraninite weighing 110 grams and containing 2.46×10^{-5} gram of radium. The growth of radium from the ionium separated from this material gave a value for the constant of change of 3.7×10^{-4} (per year), which corresponds to a half-value period of *1,836* years.

The *second* was with a specimen of Norwegian uraninite known as Cleveite, weighing 180 grams and containing 3.2×10^{-5} gram of radium. The ionium separated from this material grew radium at a rate corresponding to a value for the constant of 3.9×10^{-4} and a half-value period of *1,780* years.

The *third* was with a specimen of Norwegian uraninite of the variety known as Bröggerite, weighing 200 grams and containing 4.1×10^{-4} gram of radium. In this experiment the radium grew at a rate corresponding to 4.2×10^{-4} for the value of the constant and indicated a half-value period of *1,640* years.

In the *fourth* experiment a specimen of very pure Bröggerite was used, weighing 100 grams and containing 2.1×10^{-5} gram of radium. The value obtained for the constant of change of radium was 4.1×10^{-4} and the half-value period corresponds to approximately *1,670* years.

In this series of experiments the methods for effecting a complete separation of the ionium were progressively developed and improved. In the last two, the ones in which bröggerite was used, there were definite indications that a complete separation had been accomplished. Moreover, Miss Gleditsch also measured the amount of radium in one of my original ionium solutions in which the radium had been growing for a period of nearly seven years and found that the rate of growth had been constant throughout the entire interval. This fact disposes of the possible objection that the life of ionium is too short to give an accurate value for the constant of radium as determined by this method.

It is therefore apparent that the different methods which have been used for estimating the life of radium give results which are in excellent agreement with one another. This agreement increases the assurance with which the estimated values of certain important physical constants involved in the calculation can be accepted as approximating closely to the true values. As a matter of interest these constants will be mentioned.

Number of α-particles emitted per second by one gram of radium (element) $= 3.57 \times 10^{-10}$.

The charge carried by a hydrogen ion in electrolysis $= 4.65 \times 10^{-10}$ E.S. units.

The number of atoms in one gram of hydrogen $= 6.2 \times 10^{23}$.

The mass of the hydrogen atom $= 1.61 \times 10^{-24}$ gram.

The number of molecules in one cubic centimeter of any gas at standard pressure and temperature $= 2.72 \times 10^{19}$.

The volume of the radium emanation in equilibrium with one gram of radium

=0.62 cu. mm. calculated, =0.63 cu. mm. found.

The rate of production of helium per year per gram of radium =163 cu. mm. calculated, =164 cu. mm. found.

B. B. BOLTWOOD

A SUGGESTED EXPLANATION OF "ORTHOGENESIS" IN PLANTS

THE purpose of this paper is not to discuss what is called orthogenesis in plants in general, but to cite certain notable illustrations of it, and to suggest a possible explanation. There may be some difference of opinion as to the proper definition of orthogenesis, but it is used in this paper as standing for progressive evolution in a given direction, in contrast with more or less successful variations in several directions, involved in the theories of natural selection and mutation.

My thesis is not to prove that orthogenesis differs in kind from such explanations of evolution as natural selection or mutation, but that the persistent variation which results in what is called orthogenesis is in response to a persistent change in the conditions of living. It is an explanation of orthogenesis which contradicts its original meaning and makes it a physical rather than a vitalistic phenomenon.

Another prefatory statement should be made. The conclusions reached in this paper are not simply inferences from a series of observations, but are based chiefly upon the results of experimental work which indicates that the changes called for can be induced as responses to changed conditions.

The gymnosperms are unique among the great plant groups in the length of their available history, recorded in such a way that our knowledge of the group may be said to be fairly continuous. Other great groups are either relatively short-lived, or their records, at least so far as our knowledge of them is concerned, are very discontinuous. As a consequence, many lines of advance among gymnosperms can be traced in unbroken series from the Devonian to the present time, involving structures that have been assumed to be beyond the influences of external conditions. I wish to call attention to four such lines of advance, and to draw certain conclusions which have some bearing upon evolutionary theory.

1. *The Egg*.—A remarkable series of progressive changes is recorded as one traces the development of the female sex organ (archegonium) from the most primitive gymnosperms to the most recent. The gradual change consists in the shifting of the time of appearance of the archegonium in the ontogeny of the gametophyte (the sexual individual). In the most primitive gymnosperms the archegonia appear at what may be called the full maturity of the gametophyte, just as they do in the prothallia of ordinary ferns. An unbroken series can be traced, representing an earlier and earlier appearance of archegonia in the ontogeny of the gametophyte, extending from full maturity to very early embryonic stages. In this ontogeny three stages may be roughly distinguished: (1) free nuclear division; (2) primary wall formation; (3) growth of tissue. It is toward the end of the third stage that archegonia appear in the most primitive gymnosperms; and the gymnosperms of to-day, whose archegonia are late in appearing, as the Cycads, are primitive in this feature, though they may be advanced in some others.

As one proceeds with the history of the group, it can be observed that the appearance of archegonia shifts back through the third stage, more and more tissue being developed after their appearance. Next they are observed forming at the second stage, that of primary wall formation. In

Torreya, for example, as soon as there are walled cells at all, the archegonium initials become recognizable; and all of the tissue development (the so-called endosperm) appears after the archegonia are under way.

Finally the shift is made into the first stage of gametophyte development, that of free nuclear division, so that, of course, there is no archegonium initial, and no archegonium, as in *Gnetum,* the egg being organized in connection with a free nucleus. If one were to continue this progress into Angiosperms, he would find eggs appearing earlier and earlier in the free nuclear stage of the gametophyte, so that the free nuclei are relatively few when eggs are organized; and recently a form has been found in which the megaspore nucleus organizes an egg directly, so that this backward movement in ontogeny has reached its limit, at least in one extreme case.

Such a series of progressive changes in gymnosperms, and there are several others equally distinct, furnishes us perhaps our most impressive illustration of what Naegeli called "progressive evolution," which we have come to call orthogenesis. Here is a steady progress in a given direction through an immeasurable lapse of time, during which, presumably, the plants have been exposed to every conceivable change of conditions.

Recent experimental work upon sexuality in plants, however, may suggest an explanation for this phenomenon among gymnosperms. It is now known that the appearance of gametes (the sexual cells) is in response to certain conditions affecting metabolism. When the gamete is associated with a sex organ, as the archegonium, the conditions for gamete formation are the conditions for archegonium formation. In other words, the essential response is the gamete; a sex organ may or may not be involved. Speaking in very general terms, the conditions that favor gamete formation are associated with minimum vegetative activity. These conditions may affect the plant as a whole, in such forms as algæ, or only certain protoplasts, and in them the sex response occurs. It follows in the case of our gymnosperms that any change of conditions shortening the period of vegetative activity, would thereby hasten the appearance of eggs in the ontogeny of the gametophyte. This is exactly the result that would follow the differentiation of the year into definite seasons. In other words, this progressive change in the time of the appearance of the eggs of gymnosperms seems to hold some relation to the evolution of climate. It is significant, perhaps, that the two great living groups of gymnosperms, Cycads and Conifers, are contrasted not only in the feature under discussion, but also in geographic distribution. The Cycads, primitive in the late appearance of eggs, are tropical; while the Conifers, advanced in the early appearance of eggs, are found in the sharply differentiated seasons of the temperate regions. In any event, we know that a gamete is a response to conditions affecting unfavorably the ordinary metabolism of a plant; and the most regularly recurring variable that affects natural vegetation is climate.

2. *The Proembryo.*—A parallel illustration of progressive evolution is presented by the proembryo of gymnosperms. Unfortunately the embryos of paleozoic gymnosperms have not as yet been found, not because they did not exist, as some have imagined, but because we have not been sectioning the proper seeds. In any event, it is now becoming safe to predict their general character.

In the most primitive gymnosperms the proembryo is an extensive tissue, completely filling the large egg, best illustrated by *Gingko* among living forms. Just as in the

case of nuclear division in any large cell, there is a certain amount of free nuclear division before wall formation begins. In these primitive gymnosperms successive free nuclear divisions continue until numerous free nuclei are distributed throughout the egg, and then primary wall formation fills the egg with proembryonic tissue, consisting sometimes of hundreds of cells. The progressive change consists in the earlier and earlier appearance of wall formation in the history of the embryo, thus restricting free nuclear division, and limiting the extent of proembryonic tissue.

In the Cycads, for example, permanent proembryonic tissue occurs in every amount, from almost filling the egg (not completely filling it, as in *Gingko*) to a relatively small amount at one pole of the egg, as in *Zamia*. When this type of change is followed into the Conifers, the proembryonic tissue is found to be reduced to a few cells, and in some of the Gnetales there is no free nuclear division, so that the proembryo, in the ordinary sense, has disappeared, a condition which characterizes the angiosperms. The conditions that favor wall formation and inhibit continued free nuclear division are, of course, unknown in a definite way, but that this phenomenon is a response to some progressive change in conditions is evident.

After recognizing the kind of changes that influence gamete formation, and that perhaps explain the progressive evolution of the archegonium situation, it is of interest to discover whether these two series of progressive changes in general proceed *pari passu*. Without going into details, it may be said in general that they do. In other words, forms whose archegonia appear toward the maturity of the gametophyte have large proembryos; while those forms that have eliminated archegonia have also eliminated proembryos (that is, in the gymnosperm sense of free nuclear division as a preliminary stage). Whether declining metabolic activity favors wall formation, as contrasted with free nuclear division, as it certainly does gamete formation, I am not prepared to say; but the situation lends itself to experimental answer.

These two illustrations of progressive evolution suggest that orthogenesis does not differ from other kinds of evolution in being some kind of determinate mechanism that does not respond to a changing environment, but only in that it is a response to some progressive evolution of environment. Of course, we all realize that the word environment covers a tremendous complex of interacting factors, which the ecologist is trying to disentangle. The point made here, however, is not to suggest the factors that have been instrumental in bringing these changes to pass, but to suggest that the factors, whatever they may be, are external, and that the changes are responses. If the change is progressive, the variation in conditions is progressive.

3. *The Cotyledons.*—No feature of the embryo of gymnosperms has been more discussed than their mixture of dicotyledony and polycotyledony. The discussion has revolved about the conviction that one of these conditions must be primitive and the other derived from it. To some, dicotyledony is the primitive condition, because Cycads and Bennettitales are dicotyledonous, and they seem most primitive in other features. According to this view polycotyledony has been derived from dicotyledony by splitting. To others, polycotyledony is the primitive condition, chiefly because it is characteristic of Abietineæ, and in that case dicotyledony has been derived from it by fusion.

It would be a boon to one or the other of these schools if the embryos of Cycadofilicales or Cordaitales should be discovered, and found to be positively either polycoty-

ledonous or dicotyledonous. My prophecy is that they will be found to be both. A study of cotyledony in general has shown that these two conditions, and also monocotyledony, are merely different, and often variable final expressions of a common method of development. A cotyledonary zone or ring always develops around the growing point, and upon this ring a variable number of primordia appear, nearly always more than finally develop. The whole ring continues to develop in connection with one or two or more growing points, the others having been checked by conditions easily explained by the ontogeny of the embryo, especially by the time and position of the appearance of the immediately succeeding members. When one finds not only dicotyledony, but also polycotyledony, among the Monocotyledons, it becomes apparent that the number of cotyledons is a variable. The wonder is that it is as constant as it appears to be.

The interesting evolutionary feature is that polycotyledony is so much more common among gymnosperms than among angiosperms. It is perhaps safe to say that it was as common among most primitive gymnosperms as was dicotyledony; or rather that the number of cotyledons was much more variable than in any living group of seed plants. This interesting situation is still further emphasized by the remarkable constancy of dicotyledony in the Dicotyledons and of monocotyledony in the Monocotyledons, but I know of none of them in which less than four cotyledonary growing points start. The conditions that seem to determine the number of cotyledons to be developed by a cotyledonary ring are too numerous to be discussed here, but in general they have to do with the rate of growth of the subsequent members of the embryo. For example, if the subsequent leaves begin to appear almost immediately and develop vigorously, the cotyledonary ring usually becomes one-sided in development, and the result is a single large cotyledon in an apparently terminal position. Many monocotyledonous embryos, in which for some reason there is an elongation of the stem before the first leaves begin a vigorous growth, develop two cotyledons, as in the case of numerous grasses. This is the usual sequence in Dicotyledons; while in polycotyledonous forms there is much delay in the appearance of the subsequent members, and no inhibition of cotyledon primordia. All this variation in the number of cotyledons suggests variations in the conditions of growth, since it depends upon rate of growth in the so-called "plumule."

4. *The Seed.*—Another noteworthy illustration of progressive evolution in gymnosperms, associated with the same conditions that seem to have determined the changes previously cited, is the progressive simplification of the ovule and seed. As yet the most primitive ovule is not available, and the hiatus in our knowledge between the fern sporangium or sorus, and the most primitive known ovule is complete. In that unknown region heterospory developed, and then the seed-forming ovule, but the steps are left to conjecture. The interesting fact, however, is that the most primitive ovules and seeds we know are the most complex, and that there has been a progressive simplification through the whole series of seed plants. This simplification has not only involved the layers of the testa, as often pointed out; but its gradual progress is most completely shown by the vascular supply to the ovule and seed. The very gradual elimination of the vascular elements is a measure of the progressive simplification of the whole structure. We have found that the vascular supply does not determine the structure; but the structure determines the vascular

supply. Ovule and seed formation are associated with the closing activities of a period of growth, and any shortening of this period by a sharp differentiation of seasons should leave some impress upon ovule and seed development. This progressive simplification of the ovule deserves attention in the effort to discover its conditions; and the whole story, excepting the introductory chapter, is recorded in the history of gymnosperms.

In conclusion it may be emphasized that the gymnosperms, with their unparalleled perspective, are not only of importance in connection with the problems of the origin of seed plants and of angiosperms, but also in developing some conception of evolutionary progress quite apart from fluctuating variations or even mutations, and certainly beyond the control of any experimental work in genetics. It is obvious now that the phenomenon of progressive evolution in plants is not to be explained by any so-called "inherent tendency," but rather as a continuous response to progressive changes in the conditions for vegetative activity. When these conditions are analyzed, the response called orthogenesis in plants will become to some extent an index of the evolution of climate.

JOHN M. COULTER

UNIVERSITY OF CHICAGO

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Columbus, Ohio, during convocation week, beginning on Monday, December 27, 1915:

American Association for the Advancement of Science.—President Dr. W. W. Campbell, Director Lick Observatory; retiring president, Dr. Charles W. Eliot, Harvard University; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Mr. Henry Skinner, Academy of Natural Sciences, Logan Square, Philadelphia, Pa.; secretary of the council, Professor W. E. Henderson, Ohio State University.

Section A—Mathematics and Astronomy.—Vice-president, Professor A. O. Leuschner, University of California; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Frederick Slate, University of California; secretary, Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Professor W. McPherson, Ohio State University; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Bion J. Arnold, Chicago; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor C. S. Prosser, Ohio State University; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor V. L. Kellogg, Stanford University; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Professor W. A. Setchell, University of California; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Professor G. M. Stratton, University of California; secretary, Professor George Grant MacCurdy, Yale University; New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, Geo. F. Kunz, New York; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor F. P. Gay, University of California; secretary, Professor C.-E. A. Winslow, Yale University.

Section L—Education.—Vice-president, Professor E. P. Cubberley, Stanford University; secretary, Dr. Stuart A. Courtis, Detroit, Mich.

Section M—Agriculture.—Vice-president, Professor Eugene Davenport, University of Illinois; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

COLUMBUS

The American Physical Society.—December 28–30. President, Professor Ernest Merritt, Cornell University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Secretary, Dr. Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.

The American Society of Naturalists.—December 30. President, Professor Frank R. Lillie, University of Chicago; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 28–30. President, Professor William A. Locy, Northwestern University; secretary, Dr. Caswell Grave, The Johns Hopkins University, Baltimore, Md.

The Entomological Society of America.—December 29–31. President, Professor Vernon L. Kellogg, Stanford University; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—December 27–30. President, Professor Glen W. Herrick, Cornell University; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—President, Professor John M. Coulter, University of Chicago; secretary, H. H. Bartlett, 335 Packard St., Ann Arbor, Mich.

The American Phytopathological Society.—December 28–31. President, Professor H. H. Whetzel, Cornell University; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Nature-Study Society.—December 30–31. President, Dr. L. H. Bailey, Ithaca, N. Y.; secretary, Professor E. R. Downing, University of Chicago, Chicago, Ill.

School Garden Association of America.—December 29–30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

American Association of Official Horticultural Inspectors.—December 28–29. Chairman, W. E. Rumsey, Morgantown, W. Va.; secretary, Professor J. G. Saunders, State Capitol, Madison, Wis.

The American Microscopical Society.—December 29. President, Professor Chas. A. Kofoid, University of California; secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

American Mathematical Society (Chicago Section).—December 30 to January 1. Chairman, Professor E. J. Wilczynski, University of Chicago; secretary, Professor H. E. Slaught, 5548 Kenwood Avenue, Chicago, Ill.

The Southern Society for Philosophy and Psychology.—December 28–30. President, Professor J. C. Barnes, Maryville College; secretary, Professor L. R. Geissler, University of Georgia, Athens, Ga.

Botanists of the Central States.—Will hold no separate meeting, but will present its papers in connection with Section G. President, Professor H. C. Cowles, University of Chicago; secretary, Dr. Edward A. Burt, Missouri Botanical Garden, St. Louis, Mo.

Society for Horticultural Science.—December 28–29. President, W. L. Howard; secretary, Professor C. P. Close, College Park, Maryland.

Association of Official Seed Analysts of North America.—December 28 and 29. President, W. L. Oswald; secretary, John P. Heylar, Agricultural Experiment Station, New Brunswick, N. J.

Society of Sigma XI.—December 28. President, Chas. S. Howe, Case School; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

BOSTON

The American Physiological Society.—December 27–29. President, Professor W. B. Cannon, Harvard Medical School, Boston, Mass.; secretary, Professor Chas. W. Greene, University of Missouri, Columbia, Mo.

The American Society of Biological Chemists.—December 27–30. President, Professor Walter Jones, The Johns Hopkins University; secretary, Professor Philip A. Shaffer, Washington University Medical School, St. Louis, Mo.

The Society of Pharmacology and Experimental Therapeutics.—December 27–29. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

WASHINGTON, D. C.

The Geological Society of America.—December 28–30. President, Professor A. P. Coleman, University of Toronto; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor R. E. Dodge, Teachers College, Columbia University;

secretary, Dr. Isaiah Bowman, Broadway and 156th St., New York City.

The Paleontological Society.—December 29–30. President, Dr. E. O. Ulrich, U. S. Geological Survey; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The American Anthropological Association.—December 27–31. President, F. W. Hodge, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—Convocation Week. President, Dr. P. E. Goddard, American Museum of Natural History, New York City; sectary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

The American Economic Association.—December 28–30. President, Professor W. F. Willcox, Cornell University; secretary, Professor Allyn A. Young, Cornell University, Ithaca, N. Y.

The American Sociological Society.—December 28–31. President, Professor E. A. Ross, University of Wisconsin; secretary, Professor Scott E. W. Bedford, University of Chicago, Chicago, Ill.

NEW HAVEN

The Association of American Anatomists.—December 28–30. President, Professor G. Carl Huber, University of Michigan; secretary, Dr. Charles R. Stockard, Cornell University Medical School, New York City.

URBANA

The Society of American Bacteriologists.—December 28–30. President, Dr. D. H. Bergey, University of Pennsylvania; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

NEW YORK CITY

The American Mathematical Society.—December 27–28. President, Professor E. W. Brown, Yale University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

CHICAGO

The American Psychological Association.—December 28–30. President, Professor John B. Watson, The Johns Hopkins University; secretary, Professor R. M. Ogden, University of Kansas, Lawrence, Kansas.

PHILADELPHIA

The American Philosophical Association.—December 28–30. President, Professor A. O. Armstrong, Wesleyan University; secretary, Professor E. G. Spaulding, Princeton, N. J.

SCIENTIFIC NOTES AND NEWS

The Royal medals of the Royal Society have been awarded to Sir Joseph Larmor, F.R.S., for his contributions to mathematical and physical science, and to Dr. W. H. R. Rivers, F.R.S., for his contributions to ethnography and ethnology. The Copley medal is awarded to Professor Ivan Petrovitch Pavlov, for his investigations in the physiology of digestion and of the higher centers of the nervous system; the Davy medal to Professor Paul Sabatier, for his researches on contact action and the application of finely-divided metals as catalytic agents, and the Hughes medal to Professor Paul Langevin, for his contributions to electrical science.

The Symons Memorial gold medal of the Royal Meteorological Society has been awarded to Dr. C. A. Angot, director of the French Meteorological Bureau.

Dr. Henry Shoemaker Conard, professor of botany at Grinnell College, has been appointed visiting lecturer on botany at Harvard University for the second half of the academic year.

Dr. W. A. Orton and Dr. C. L. Shear, of the United States Department of Agriculture, have been appointed delegates from the American Phytopathological Society to the Second Pan-American Congress meeting in Washington, December 27 to January 8.

Staff-Surgeon G. M. Levick has been specially promoted to the rank of fleet surgeon in the British navy for his services with the British antarctic expedition in 1910.

Dr. Wilfrid T. Grenfell, known for his work in Labrador, has accepted an invitation to take charge of a division of a hospital unit sent to France by Harvard University. He will return in the spring to Labrador.

Dr. William H. Heath, of Buffalo, has been appointed executive medical adviser and sanitarian to the king of Siam. His duty will be to establish modern sanitary conditions in that country.

H. H. Clayton, in charge of the forecast department for the Argentine Weather Bureau, is returning to this country for a visit.

Word has reached the American Museum of Natural History that both the Crocker Land expedition and the relief party sent to its aid will spend the winter ice-bound in the Arctic. Letters received from Donald B. MacMillan, leader of the Crocker Land expedition, by way of Copenhagen, said that the men of his party were in good health and were preparing to spend the winter in the Arctic regions, and to continue explorations in the spring. Dr. Edmund O. Hovey, who is leading the relief party on the steamer *George B. Cluett*, reports his ship frozen in at North Star Bay, 120 miles north of Etah, the base of the MacMillan expedition.

The third regular meeting of the session of the New York Section of the American Chemical Society was held in Rumford Hall, on the evening of December 10, in conjunction with the New York Section of the Society of Chemical Industry and the American Electrochemical Society. This meeting was the second of the series dealing with the subject of "University and Industry." The speakers announced were Richard C. Maclaurin, president, Massachusetts Institute of Technology; Henry P. Talbot, professor of inorganic chemistry, Massachusetts Institute of Technology; William H. Walker, professor of chemical engineering, Massachusetts Institute of Technology; Arthur D. Little, member of corporation, Massachusetts Institute of Technology. These papers were followed by an address on "The Naval Consulting Board of the United States," by Dr. L. H. Baekeland and Dr. W. R. Whitney, members of the board.

Professor W. S. Franklin recently gave two addresses before the Physical Science Club of Oberlin College. His subjects were: "Bill's School and Mine" and "Some Phenomena of Fluid Motion—The Curved Flight of a Baseball."

Professor G. A. Mitchell, director of the Leander McCormick Observatory, University of Virginia, lectured at the Brooklyn Institute of Arts and Sciences, on November 20, on "The Exact Distances of the Stars." On November 22 he lectured in Harrisburg before the Natural History Society on "The Sun."

Dr. John Pogue Stewart, professor of experimental pomology in the Pennsylvania State College, addressed the Illinois State Horticultural Society at the University of Illinois, on December 15 and 17. The subjects presented were "Methods of Influencing Yield and Commercial Quality in Apples" and "Latest Developments in Sulphur Sprays."

A bronze statue of Captain R. F. Scott, R.N., subscribed for by officers of the British navy, has been erected in Waterloo Place, London. The statue, which shows the explorer in polar dress, is the work of Lady Scott. Mr. A. J. Balfour, first lord of the admiralty, unveiled the statue on November 5.

Carl Axel Robert Lundin, maker of many of the largest telescopic lenses in the world, died at his home in Cambridge on November 28.

Professor Edouard Prillieux, member of the French Academy of Sciences, known for his work in botany and especially phytopathology, died on October 8, at the age of eighty-six years.

Professor Hans Gross, a distinguished Austrian criminologist, has died at the age of sixty-eight years.

Section M (Agriculture) of the American Association for the Advancement of Science will hold two sessions, in Townsend Hall, University of Ohio, on Tuesday, December 28. The morning session, at 10 o'clock, will be devoted to the vice-presidential address of Professor L. H. Bailey, on "The Forthcoming Situation in Agricultural Work." At the afternoon session at 2 o'clock, a symposium will be presented on "The Relation of Science to Meat Production." The subject will be introduced by President W. O. Thompson, of Ohio State University, and will be developed by the following speakers:

President H. J. Waters, Kansas State Agricultural College, on "Food in Relation to Growth and Meat Production."

Professor L. D. Hall, Office of Markets, U. S. Department of Agriculture, on "Economic Aspects of Meat Production and Marketing."

Professor Herbert W. Mumford, University of

Illinois, on "The Problem of Meat Production on the High-priced Lands of the Middle West."

Dr. A. R. Ward, Bureau of Animal Industry, U. S. Department of Agriculture, on "Disease Control as a Factor in Meat Production."

THE kite photography expedition which has been making aerial views over the crater of Kilauea Volcano for the past six months under the expert direction of C. F. Haworth, C.E., has returned with a series of views from lofty positions, showing the volcano as it has never before been viewed. This difficult feat, under most trying conditions of winds, calms and volcanic emanations, has been done to add necessary data to the photographic survey made for the large naturalistic model of Kilauea which has now been under constant construction for nearly three years for the Harvard Geological Department, the first work of this class yet supported by American geologists. Only one other comparable work has been constructed in this country, the model of the coral island "Bora Bora," for the Agassiz Museum. These naturalistic land reliefs by the geologist land sculptor, Curtis, belong to a new field of geology, which is bringing a fresh and wider interest into the earth sciences.

THE *Journal* of the American Medical Association states that the damage suit against Rockefeller Institute for $200,000, brought by two of the former employees of the institute, was dismissed in the United States District Court on November 4. The plaintiffs in the case alleged that the doctors had persuaded them to submit to the injection of serum from which they had become infected with an incurable disease. The court held that the facts were insufficient to constitute a cause of action.

THE New School of Tropical Medicine and Research Laboratories in Calcutta are, according to the *Pioneer Mail*, as quoted by *Nature*, now ready for occupation. They will be associated with the Calcutta Medical College, so that a constant supply of tropical material will be available for study. A subject to which study will be devoted will be the pharmacology of Indian drugs. The number of research workers at present arranged for is eight.

DR. L. H. PENNINGTON, forest pathologist of the New York State College of Forestry at Syracuse, has just found the chestnut tree blight in a chestnut grove at Sand Ridge not far from Phoenix. This is the first report of an occurrence of the blight in this section of New York state. The presence of the blight in Oswego County indicates that the chestnut trees in all parts of the state will sooner or later be attacked. The occurrence of the blight at Sand Ridge is in the form of a spot infection where but a single tree is found to be infected. The tree in this instance was already completely girdled and killed and the fungi in fruiting condition. Other trees may therefore have been infected before this one was discovered and removed. If these spot infections can be discovered in time and the diseased trees removed and destroyed at once, the general spread of the disease may be retarded and the life of chestnut groves prolonged several years in this part of the state.

A GIFT of $1,000, unusual in the conditions under which it was offered, has been accepted by the trustees of Cornell University from an anonymous donor. The money was placed under the control of Professor G. D. Harris, of the department of geology, with the stipulation that "payments shall be made from the fund to Professor Harris as and when he requests and no accounts shall be required beyond simple receipts from Professor Harris saying that the sum or sums he may request from time to time have been received and that they are to be expended for purposes which in his opinion will be of assistance to a student or students of geology as the case may be." Following the stipulation concerning the use of the money the anonymous donor explained his position with a tribute to Professor Harris's work as geologist and teacher. "I may perhaps explain," writes the donor, "that it has been my privilege to attend courses at three universities, the University of Indiana, Cornell University and the University of Wisconsin, and at none of these have I known of any man who so fully as Professor Harris had the real training and development of his students at heart or who in so extreme a degree

of unselfishness lived only for their good and for the advancement of the science."

REGISTRATION for the new courses in public health administration, offered by the University and Bellevue Hospital Medical College, indicate that many health officers, both of the New York City's health department and from other localities of New York State, are taking work in compliance with the new requirement of the New York State Public Health Council. Those connected with the municipal health department who have enrolled for this work now number twenty, while the enrollment of those who have elected the correspondence method for meeting the new ruling has reached a total of fifty. The new courses, which were first offered by the university during the past summer, have been arranged in accordance with the new regulation of the Public Health Council, which has made it obligatory for health officers to supplement their professional education with further instruction in administering to the general health of the community. For students who have previously secured their M.D. degree, upon the completion of one year of study, including actual attendance at lectures and laboratory work, it is possible to earn the degree of doctor of public health.

FROM investigations carried on by the New York State College of Forestry, at Syracuse, in the basket willow growing section about Liverpool and Lyons in New York state and in the study of reports of basket manufacturers, it finds that the bulk of the willow ware used in the United States is manufactured in the little town of Liverpool, just north of Syracuse. The Liverpool shops use over 3,000 tons of basket willow stock which is 75 per cent. of the total stock used in the country. About a year ago basket willow stock was bringing from $20 to $25 per ton delivered at the Liverpool factories. To-day, owing to the cutting off of the foreign supply the prices average about $30 a ton, and that in spite of the increased local production. There are few industries using the products of the forests where there is as little waste as in the basket willow industry. The only part of the willow stem or cane that is thrown away is the bark. The College of Forestry is planning to carry on investigations in the Eastern Forest Products Laboratory to see whether the bark of the willow does not have some use as a source of certain chemical products. The returns from land upon which basket willow is grown are larger than the returns from any crop produced on lands in the state outside of nursery stock. Often land of little or no value because of its wet condition can be used for the growing of willow and as culture is not necessary there is practically no labor except at the time of cutting in the fall. Cutting is usually carried on in November and as the canes are taken out they are tied up in bundles of from 50 to 100 each. At the factory the canes are steamed, peeled and dried and are then ready for use. In sections about Liverpool and about Lyons it has been estimated that owners of willow holts often take in from fifty to one hundred dollars per acre per year over a growing period of 30 years.

UNIVERSITY AND EDUCATIONAL NEWS

A GIFT of $150,000 to Harvard University with which to found a professorship in archeology is contained in the will of Mrs. Eunice Melles Hudson, widow of a former president of the American Bell Telephone Company, which was filed for probate here.

ON the recommendation of the minister of public instruction, there were created by a decree dated October 7, 1915, a chair of topographic anatomy and a chair of bacteriology in the Faculté de médecine of the University of Paris.

THE committee of inquiry of the American Association of University Professors which is preparing a report on the case of Dr. Scott Nearing, of the University of Pennsylvania, consists of the following: Professors Davis R. Dewey, Massachusetts Institute of Technology; Henry Farnam, Yale University; F. H. Giddings, Columbia University; Roscoe Pound, Harvard University; A. O. Lovejoy, *Chairman*, Johns Hopkins University.

DR. FREDERICK A. WOLF, plant pathologist of the Alabama Agricultural Experiment Sta-

tion, has accepted the position as head of the department of botany and plant pathology in the North Carolina Agricultural and Mechanical College, West Raleigh, N. C. He will enter upon his new duties on January 1.

ARTHUR S. RHOADS, who has a bachelor's and master's degree in science from the Pennsylvania State College, has recently taken a position as assistant in forest pathology in the New York College of Forestry.

DR. E. W. A. WALKER, fellow of University College, Oxford, has been appointed lecturer in pathology.

DISCUSSION AND CORRESPONDENCE

PRE-CAMBRIAN NOMENCLATURE

TO THE EDITOR OF SCIENCE: The State Geological Reports often contain facts which are of wide interest but which are liable to be overlooked. As all general conclusions must depend on local facts, it seems to me to be the duty of those who recognize the wide bearing of these local facts to bring them to public notice. I have just received a book[1] in which the results of the "Contributions to Pre-Cambrian Geology" by R. C. Allen, affect not merely Michigan, but the whole subject of Pre-Cambrian nomenclature. For instance the very interesting and valuable tables published by Miller and Knight showing the correlation of Pre-Cambrian rocks[2] might be revised by the authors in view of this publication.

Now the main point is this: Andrew C. Lawson in his study of the pre-Cambrian rocks urges that the Animikie, which has always been considered a part of the Huronian period, is a period independent of, and later than the Huronian period. The author, R. C. Allen, shows good reason to believe that the Gogebic which has always been correlated with the Animikie should be correlated with the *middle* Huronian. He accordingly correlates the Animikie as *middle* Huronian. This seems to me to be worthy of mention in as much as Allen has not confined himself to work in Michigan but has worked in the original Animikie region. I first met him there.

Now, in view of these facts, I may put in print suspicions which I have only breathed in conversation, namely, that in the original Huronian where there are bright bits of jasper in the Thessalon conglomerate, they were derived from a *middle* iron-bearing series which is not well represented in that area. In view of the facts brought forward by Allen which indicate that the Gogebic was invaded by granite intrusions, and then later was overlaid unconformably by another formation, the Copps formation, it seems to me it would be very premature to make the changes suggested by Lawson or by Miller and Knight. I have no doubt the facts presented in this report will have to be carefully scrutinized by these writers, who will undoubtedly form their own conclusions.

In the meantime we must be very careful about trying to make widespread pre-Cambrian subdivisions. In any one district the division line between those strata affected by granite intrusions and metamorphosis and those not so affected is marked, and such was practically the line between the Huronian and Laurentian as originally mapped. But it becomes more and more clear that granite intrusions on a large scale have taken place in different regions at different dates. And it is very doubtful to me whether the habit of grouping granite intrusions under names which are more or less correlated with inter-geologic periods is a wise arrangement.

The same report contains a valuable paper by Case and Robinson which emphasizes and shows the correctness of the downward salients of Schuchert's curve showing the extent of the ocean in those times in the paleozoic section in Michigan. What we need to do for the pre-Cambrian is to adopt the same laborious process that Schuchert has completed and see if possibly different types of strata, such as the great Middle Huronian (Mio-Huronian) iron-bearing formation may not, as I have suggested, correlate with definite stages in the

1 Pub. 18, Geol. Series 15, Mich. Geol. and Biol. Surv., by Allen and Barrett.

2 P.-C. Geol. of SE. Ont., by Miller and Knight, Rep. Bureau of Mines, Vol. XXII.

evolution of air and ocean under the influence of early life. Mr. Allen has made an important contribution to pre-Cambrian geology, of far more than local value.

ALFRED C. LANE

MEMBERS HOLDING LONGEST CONTINUOUS MEMBERSHIP IN THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THROUGH a clerical oversight, by reason of the original list having been drawn up for another purpose, the following names were inadvertently omitted from the roll of those who now hold the longest continuous membership in the American Association, printed in SCIENCE for December 3. It will be noted that all in the following list are Life Fellows of the Association.

*Hitchcock, Charles Henry, Ph.D., LL.D., Honolulu, Hawaii. (11.) 1874. E.

*Lyman, Benjamin Smith, E.M., 708 Locust Street, Philadelphia, Pa. (15.) 1905. E.

*Gilbert, Grove Karl, LL.D., U. S. Geological Survey, Washington, D.C. (18.) 1874. E.

*Morse, Edward Sylvester, Ph.D., Peabody Museum, Salem, Mass. (18.) 1874. F, H.

*Stephens, W. Hudson, Lowville, N. Y. (18.) 1874. E, H.

*Warner, James D., 463 East 26th Street, Flatbush, Brooklyn, N. Y. (18.) 1874. A, B.

*Hanaman, Charles Edward, Troy, N. Y. (19.) 1883. F.

*Mendenhall, Thomas Corwin, Ph.D., Sc.D., LL.D., 329 North Chestnut St., Ravenna, Ohio. (20.) 1874. B.

L. O. HOWARD,
Permanent Secretary

PAN-AMERICAN

TO THE EDITOR OF SCIENCE: Will you kindly tell me the scientific meaning of Pan-American? Is Canada in or out of the Pan?

OTTO KLOTZ

OTTAWA,
December 9, 1915

SCIENTIFIC BOOKS

Tierbau und Tierleben. VON R. HESSE und F. DOFLEIN. Band 2. Das Tier als Glied des Naturganzen von F. Doflein. B. G. Teubner, Leipzig und Berlin. 8vo. Pp. xv + 960. 740 text illustrations and 20 plates.

The second volume of Hesse and Doflein's "Tierbau und Tierleben" has just been issued by Teubner, of Berlin and Leipzig. The first volume, from the pen of Professor Hesse, appeared in 1910 and dealt with the structure and functions of the animal body. The companion volume, the work of Professor Doflein, bears the date of 1914 and takes up the consideration of the animal as an element in nature. It is divided into three books. The first has to do with animals in their relations to their organic surroundings and deals with their feeding habits, their means of defense, their sexual life, their migrations, the care of their young, and their social life. The second book treats of animals in their relations to their inorganic environment, such as general cosmic changes, the surrounding medium and the substrate, the quantity and quality of food, temperature and climate, and light. The third and last book has to do with the adaptive structures and activities of animals, and the explanation of these phenomena. The volume contains almost a thousand pages and is illustrated by some twenty plates and over seven hundred text-figures. The press work, including the illustrations, is beautifully done. Gothic type, however, gives the page a less modern scientific aspect than Roman would have done. Some of the illustrations, like Fig. 574 of the sleeping places of Indian birds, verge more on the theatrical than on the natural; others, like Liljefors' grouse and wild-goose plates, are really wonderful works of art. Here and there a few mistakes are to be noted; thus Fig. 721 is incorrectly attributed to Packard. But in such a wealth of material it is impossible to comment critically. Suffice it to say that the immense body of new and accurate information brought together in this volume will make it a most welcome addition to the present source of information used by the modern zoological reader.

G. H. PARKER

Flora of New Mexico. By E. O. WOOTON and PAUL C. STANDLEY. Contrib. U. S. National Museum, Vol. 19. 1915. Pp. 794.

Many years ago Professor E. O. Wooton, then in charge of the department of botany at the New Mexico Agricultural College, planned a flora of New Mexico. It was at first expected that the work would be finished in a few years, but various difficulties arose, while every new locality examined furnished additions to the list of species. Thus, as the years passed, the collections tended to run ahead of the work done on them, and the completion of the flora appeared more remote than ever. Eventually, Mr. Paul C. Standley became Professor Wooton's assistant, and through the joint labors of the two the flora made rapid progress; after both had moved to Washington, and were in a position to consult the larger herbaria, it was finally completed. It was then offered to the National Museum for publication, and met with the usual delays. Owing to its great size, it had to be condensed, everything not considered essential (*e. g.*, names of collectors) being cut out. As it now appears, it is a bulky volume, containing an enormous amount of information. The number of species treated in 2,975, but, as the authors state, the actually existing flora is doubtless much greater. Considerable areas in New Mexico have never yet been visited by a botanist, while others have only been superficially examined. Though the "Flora of New Mexico" is necessarily of the nature of a preliminary survey, it forms an excellent guide to the plants of the state, and is reasonably complete for all the better known localities. Each genus is briefly defined, all the species are included in very clearly written keys, and in addition there are numerous remarks which greatly facilitate the ready recognition of the various plants. The type locality, general range and range in New Mexico are given. It would be hard to imagine a more useful and adequate treatment of the subject within the space-limits imposed. After spending many hours in the study of the book, the reviewer finds his admiration for it increasing with greater familiarity, a process the reverse of that experienced in relation to some other works of the same general type. There may be, there certainly are, matters which will require amendment, but we appear to have the best presentation which years of study in the field and herbarium, and careful consideration of all the available evidence, can give at the present time.

The new species found in the course of the investigation have been very numerous, including members of such genera as *Yucca, Agave, Quercus, Clematis, Rosa* (two), *Amelanchier, Padus* (six), *Lupinus, Robinia, Rhus, Acer, Garrya, Sambucus*, etc., etc. Although New Mexico is bordered by Colorado on the north, it contains a very large number of species not found in the latter state. How many of these are really endemic or precinctive can not be ascertained until the plants of Arizona and Chihuahua are better known, but it is practically certain that several at least are confined to some of the large mountain groups. In discussing Wooton's cocklebur, *Xanthium commune Wootoni*, it is remarked that it appears to be a distinct species, but is not placed as such on account of the occurrence of *commune* and *Wootoni* burs in a single instance on the same plant. DeVries ("Species and Variation," 1905) grew *X. Wootoni* from seed, and found it to come true; in his discussion of it he provided a binomial designation. The reviewer, two years ago, found a specimen of *X. commune* in a greenhouse at Boulder, having several *Wootoni*-like burs, although no *X. Wootoni* has ever been seen in Colorado. We must apparently conclude that *X. Wootoni* is a valid species, but that *commune* from time to time varies or mutates to a virtually identical form.

T. D. A. Cockerell

University of Colorado

SCIENTIFIC JOURNALS AND ARTICLES

The concluding (October) number of volume 16 of the *Transactions of the American Mathematical Society* contains the following papers:

W. V. Lovitt: "A type of singular points for a transformation of three variables."

J. K. Lamond: "The reduction of multiple *L*-integrals of separated functions to iterated *L*-integrals."

G. A. Miller: "Independent generators of a group of finite order."

C. N. Haskins: "On the zeros of the function, $P(X)$, complementary to the incomplete gamma function."

Edward Kircher: "Group properties of the residue classes of certain Kronecker modular systems and some related generalizations in number theory."

C. de la Vallée Poussin: "Sur l'intégrale de Lebesgue."

G. E. Wahlin: "A new development of the theory of algebraic numbers."

A. F. Carpenter: "Ruled surfaces whose flecnode curves have plane branches."

The opening (October) number of volume 22 of the *Bulletin of the American Mathematical Society* contains: Report of the twenty-second summer meeting of the society, by Thomas Buck; "Groupless triad systems on fifteen elements," by Louise D. Cummings and H. S. White; "Note on Green's theorem," by C. A. Epperson; "Convergence of the series

$$\sum_{i=0}^{\infty}\sum_{j=0}^{\infty}\frac{x^i y^j}{i-j\gamma}$$

(γ irrational)," by W. D. MacMillan; "A certain class of functions connected with Fuchsian groups," by Arnold Emch; "Professor Bôcher's views concerning the geometry of inversion," by Eduard Study; "The Davis calculus," by E. W. Davis; "Notes"; and "New Publications."

The November number (Vol. 22, No. 2) of the *Bulletin* contains: "On the relation between linear algebras and continuous groups," by L. E. Dickson; "An aspect of the linear congruence with applications to the theory of Fermat's quotient," by H. S. Vandiver; "Limits of the degree of transitivity of substitution groups," by G. A. Miller; "The permutations of the natural numbers can not be well ordered," by A. B. Frizell; "Relations among parameters along the rational cubic curve," by J. E. Rowe; Review of Vallée Poussin's Cours d'Analyse Infinitésimale, third edition, by M. B. Porter; Review of Zeuthen's Lehrbuch der abzählenden Methoden der Geometrie, by E. S. Allen; Review of Carslaw's Teaching of Mathematics in Australia, by R. C. Archibald; "Shorter Notice": Loria's Per la Biografia di Giovanni Ceva, by D. E. Smith; "Notes"; and "New Publications."

SPECIAL ARTICLES

THE MOUNTING OF CELLOIDIN SECTIONS IN SERIES

Investigators in both normal and pathological plant histology have to often resort to celloidin for embedding parts of plants which contain a considerable amount of lignified tissue, as the sections are very apt to break up badly in cutting if the material is embedded in paraffin.

The process of cutting and mounting celloidin sections is very simple if only occasional sections are required for study, as they can be stained and mounted separately. It is sometimes desirable, however, to examine a whole series of sections, in which case it is necessary to stick the sections to a slide before staining them, which greatly increases the difficulty. Plowman[1] has described a method of this kind which very briefly is as follows: As the sections are cut they should be transferred to a piece of smooth thin paper, and when they are dry the paper should be turned face downward on a slide which has previously been coated with albumen fixative. Add several layers of paper, press down, and roll with a roller. Place another slide on top of the sections, clamp down, and dry for a few hours.

I have had occasion to use the above described method on various occasions with rather poor success. The paper is very apt to stick to the edges of the sections and either tear them badly or pull some of them away from the slide when the paper is finally removed. The use of oiled paper will not entirely obviate this difficulty unless the paper is very oily, in which case it is apt to prevent some of the sections from sticking to the slide if some of the oil gets beneath them. I have found, furthermore, that it is necessary to use a much thicker solution of albumen than for paraffin sections, which is apt to become deeply colored in the subsequent staining, resulting in messy looking slides.

[1] *Bot. Gaz.*, 37, pp. 456–461.

Land[3] has recently described a fixing fluid for paraffin sections which is much superior to the albumen fixative in general use. I have been using a similar fluid for some time and have found that it works equally well for celloidin sections, and much better than the albumen method of fixation as described by Plowman. Land gives a formula for making the fluid for paraffin sections, but for celloidin sections I have found that by placing a few small pieces of gum arabic in distilled water and shaking until the bubbles formed cease to break readily, enough of the gum will be dissolved to answer all purposes. A sufficient amount of potassium bichromate should be added to give the fluid a slightly yellow color. Land advises adding the bicromate when the sections are mounted, but by preserving the fluid in a blackened bottle it will keep in good condition for months.

Two methods may be used in mounting the sections. If they are small and the entire series can be arranged on one or two slides, the knife can be wet with 90 per cent. alcohol when cutting, and the sections removed to a clean slide as they are cut. After the slide has been covered with sections, the alcohol is allowed to dry, or is removed with a small piece of filter paper. A drop of the fixing fluid is now added and the slide tilted to allow it to run underneath the sections. The excess of fixing fluid should be removed by placing a piece of filter paper on top of the sections and gently pressing down. If care is exercised in doing this it is very seldom that any of the sections will adhere to the paper. Occasional sections that do adhere, however, can be easily removed from the paper and put in place again. Another slide should be slightly oiled and placed on top of the sections, after which it is clamped down. The slide should be left to dry in strong sunlight for a few hours.

If the sections are rather large and it is not necessary to save the entire series, the knife can be wet with glycerine alcohol and the sections removed to a large slide or piece of glass as they are cut. Such sections as are needed for study can be subsequently transferred to another slide, first carefully washing them to remove all traces of glycerine.

If care is taken in removing the excess of fixing fluid from the sections at the start, the oiled slide can be removed after drying without injuring any of them. I have mounted as many as one hundred rather large sections in series by this method and they all came through in perfect condition.

ALBAN STEWART
UNIVERSITY OF WISCONSIN

[3] *Bot. Gaz.*, 59, pp. 397–401.

THE RÔLE OF ANOPHELES PUNCTIPENNIS SAY IN THE TRANSMISSION OF MALARIA

As the result of recent experiments conducted in New Orleans, Louisiana, *Anopheles punctipennis* Say has proved itself to be an efficient medium for the development of the sexual cycle of the organism of tertian malaria, *Plasmodium vivax.*

Of previous attempts to determine the exact status of this species of *Anopheles* the most thorough was that of Hirschberg who in a series of carefully executed experiments obtained only negative results in infecting *A. punctipennis* with the gametes of estivo-autumnal malaria. As further evidence of this negative rôle, he states that no cases of malaria were found to be developing in a certain section of Maryland where the species was common, and that he had never found naturally infected *punctipennis* here or elsewhere as had been done with *A. quadrimaculatus.*

Dupree, however, in a list of efficient hosts of malaria includes *punctipennis* as having been so determined by himself. No other details are given and Knab in 1913 was inclined to the belief that he had in reality experimented with *A. punctipennis*, which is now recognized as a distinct species and as an efficient host.

Anopheles punctipennis is one of the common species of the genus in the United States and because of its abundance and wide distribution the question of its agency in the spread of malaria is an important one. To record the fact that the parasites of one form of the disease may successfully develop in this species is the purpose of the present note, which will

be followed by a more detailed account of experiments.

On November 6, 1915, six specimens of *A. punctipennis* were allowed to feed on a patient in whose blood had been demonstrated the gametes of tertian malaria. The mosquitoes had been bred from larvæ and before and after the blood meal were given only raisins and water as food. They were kept at room temperature and were dissected and examined in the usual way after intervals of 7 days (two specimens), 9, 18, 20 and 24 days. The first four showed a moderate to heavy infection of the stomach with oocysts. In the one examined on the twentieth day were found mostly rupturing and ruptured oocysts and an intense invasion of the salivary glands with sporozoites—the form which is inoculated by the mosquito into the human host. The sixth specimen alone proved to be negative and in this one the condition of the ovaries suggested the explanation that this may have been due to the ingestion of only a small amount of infective blood.

On a second case of tertian malaria having a much fewer number of gametes, a single specimen of *A. punctipennis* was fed on November 12. Upon dissection on December 2, a light infection of both the stomach and glands was found to exist.

In each experiment bred specimens of *A. quadrimaculatus* were fed on the patients as controls and these also showed a high percentage of infections upon subsequent examinations.

The demonstration that *A. punctipennis* is an efficient host for tertian malaria does not necessarily indicate that it is an efficient carrier of other forms of malaria and, in fact, from Hirschberg's results we may anticipate that such is not the case.

The writer is indebted to Dr. C. C. Bass and Dr. F. M. Johns of the laboratories of clinical medicine of Tulane University for assistance in the work upon which this statement is based and to Mr. F. Knab for the verification of the determination of the mosquito.

W. V. King

Bureau of Entomology,
U. S. Department of Agriculture

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION G, BOTANY

PACIFIC COAST MEETINGS

The following officers were present: Professor W. A. Setchell, sectional vice-president; Professor L. L. Burlingame, acting secretary. The meetings were held in the Hearst Mining Building, University of California, with the exception of the meeting on August 4, which was held in the Botany Building, Stanford University. The following papers were read:

Tuesday, August 3

The Embryo of the Gymnosperms: Professor John M. Coulter, University of Chicago.

Attention is called to three features of Gymnosperms: the proembryo, the archegonium and the cotyledons.

Proembryo.—The proembryo presents every gradation from a tissue completely filling a large egg to such segmentation of the egg as occurs in Angiosperms. This series represents a progressive change extending from the Devonian to the present time. No better example of progressive evolution, or orthogenesis, can be found. The change is due to the fact that wall-formation begins earlier and earlier in the history of the embryo, thus restricting free nuclear division and limiting the amount of proembryonic tissue. The conditions that favor wall-formation and inhibit continued free nuclear division are unknown, but that this phenomenon is a response to some progressive change in conditions is evident.

Archegonium.—A similar series of progressive changes is shown in the development of the archegonium, extending from the appearance of archegonia at the full maturity of the gametophyte, through forms in which they appear earlier and earlier in the ontogeny of the gametophyte, and ending with the maturation of eggs at the free nuclear stage, resulting in the elimination of archegonia. The conditions for gamete-formation as contrasted with those for vegetative activity, are getting to be known through experimental work. This progressive change, therefore, is to be explained by the gradual earlier appearance of conditions for gamete-formation, which in general are conditions of minimum vegetative activity. In all probability, these are the conditions that also favor earlier wall-formation in the ontogeny of the proembryo.

Cotyledons.—Evidence is now at hand to prove that polycotyledony and dicotyledony are merely

different final expressions of a common method of development. Polycotyledony was more common in the primitive gymnosperms; and neither coalescence nor splitting explains the two conditions.

Discussion: Professors Clements and Campbell.

Methods of Pollination and Evolution of the Male Gametophyte: L. L. BURLINGAME, Stanford University.

There are four types of pollination devices and male gametophytes found among the Gymnosperms as follows:

1. The Cycadofilicales and Cordiatales male gametophyte has numerous cells in its pollen grain. It is as yet uncertain whether they are spermatogenous or prothallial. No pollen tubes of any sort were formed. The pollen grains were lodged in pollen chambers in the nucellus.

2. The Cycadales have a single prothallial cell, a pollen chamber, swimming sperms and a haustorial pollen tube that is probably to be homologized with the rhizoid of their ancient Pteridophyte ancestors.

3. The Araucarian conifers have a multicellular prothallus, non-ciliated sperms, and a protruding nucellus without a pollen chamber. The pollen lodges on the ovuliferous scale at a distance from the nucellus and forms a long branching haustorial pollen. This tube is probably to be homologized with the germ tube and not the rhizoid of their pteridophytic ancestors. It is not homologous with that of the cycads, since it does not have the same function, grow in the same direction, and was probably derived from different ancestors.

The Abietinean conifers have short direct pollen tubes, two evanescent prothallial cells, and non-ciliated sperms. They could readily have been derived by reduction from the araucarian type. There seems to be very little probability of the reverse process, since such a course of evolution would be accomplished through a number of intermediate steps each of which is apparently distinctly disadvantageous to the plants adopting it.

Some Notes on Western Species of Cupressus: L. R. ABRAMS, Stanford University.

Among the Californian conifers the genus *Cupressus* occupies an important position in point of interest to the botanist, and especially to the plant geographer. The true cypresses belong to warm temperate climates, and are associated in our minds with the sunny Mediterranean countries. But *Cupressus* is not altogether an old world genus; fully half if not more of the species are North American, and more are in California than in any other one section.

Turning to the geological records we find that in Tertiary time *Cupressus* flourished in Greenland and northern Europe. The present far separated eastern and western branches, then, like torreyas and sequoias, are the remnants of a once widely distributed race. The local distribution of the California species, which seldom or never form forests but exist in small isolated groves, is also suggestive of a decadent race, once flourishing but now struggling against the invaders of a new age.

Up to the present time five species have been recognized in California: *C. macrocarpa* Hartw., *C. goveniana* Gord., *C. macnabiana* Murr., *C. sargentii* Jepson and *C. bakeri* Jepson. Two remote groves, little understood or unknown to those who have undertaken to monograph the genus, have proved after careful field studies to be distinct from other Californian species. Those of San Diego County, which previously have been placed in *goveniana*, are in no way related to that species, but belong to the smooth-trunked group represented by *guadalupensis*. The other, an hitherto unknown grove situated in the Piute Mountains is the only grove in the Sierra Nevada. This species has the glandular foliage of *macnabiana* and *bakeri*, but the fruit is more the nature of *goveniana*. It is unquestionably distinct from these, however, and is to be described as a new species.

Geologic History of the Gymnosperms: E. W. BERRY, Johns Hopkins University (read by FORREST SHREVE).

Wednesday, August 4

Morphogenic Effects of Light: GEORGE J. PEIRCE, Stanford University.

Stimuli are sometimes classified as formative and directive. The influence of a given stimulus may be due to its quantity, the direction from which it is received, etc. Then we find the *quantity* of light exercising a distinct effect upon the quantity, and inferentially upon the growth. This is plainer perhaps in parts of the world where the quantity of light falling upon the earth's surface is greater than elsewhere, owing to the dryness and cleanness of the atmosphere. The top of the forest and the upper surface of the chaparral are remarkably flat, despite the number of species composing each. That light is a factor in determining this is shown by the behavior of *Escholtzia*, bur clover, geranium, mint and other plants, wild and cultivated, coming up in chaparral, hedges, vines, etc. These ordinarily short plants may become extraordinarily long under these special conditions of light.

The *direction* from which light comes also determines the form which certain plants assume.

This is shown by plants cultivated from the spore upon a clinostat revolving a horizontal plane. To avoid error from single cultures, or from successive cultures on the same instrument or instruments, a multiple clinostat has been devised, which revolves forty or more turn-tables simultaneously. This weight-driven multiple clinostat will be shown to all interested.

Discussion: MacDougal and Clements.

Theories of Photosynthesis in the Light of Some New Facts: H. A. SPOEHR, Department of Botanical Research, Carnegie Institution of Washington.

The Distribution and Succession of the Flowers of the Giant Cactus in Relation to Isolation: D. S. JOHNSON, Johns Hopkins University.

The flowers of *Carnegiea gigantea* growing about Tucson, are rarely symmetrically grouped about the growing point of the massive stem. They are usually most abundant on the east side and least abundant, or wanting, on the west side. If more evenly distributed about the circumference, the flowers are larger and open first on the east side. This is true of plants on all slopes and of branches as well as of the main axis.

The most evident external factors which may be concerned with this peculiar distribution of the flowers are sunlight and the air temperature. In the season of hot days and cold nights, prevailing when the flowers are developing, the morning sun would increase the temperature, and so the rate of growth on the east side of the crown first. The high air temperature during midday would allow this temperature of the east side of the cactus to be maintained till late afternoon. The opposite or west side, on the contrary, would probably not reach its maximum temperature till mid-afternoon, or later not long before the evening cooling of the air sets in.

Discussion: Lloyd, MacDougal and McCallum.

Demonstration by Peirce and McMurphy of smelter smoke effects on vegetation.

Thursday, August 5, 10 A.M.

Factors Affecting the Distribution of the Components of the Flora of California: DOUGLAS H. CAMPBELL, Stanford University.

1. The geographical position of California, more or less shut off from the eastern states by its mountains and the deserts, results in a flora very different from that of other parts of the United States. There is an unusual proportion of plants peculiar to the state.

2. The climate of California, especially the coast region, is dominated by the Pacific Ocean—the climate, compared to Atlantic American, is very mild and equable. Topography, rather than latitude, regulates the temperature, *e. g.*, there is apt to be more difference between the maximum of San Francisco and Sacramento, than there is between Eureka and San Diego.

3. Rainfall conditions show a wide range, exercising a great influence upon its floras of different parts of the state. Thus the flora of the redwood belt of the northern coast has probably not a single plant found in the arid district of the southeast, like the Colorado desert.

The prevalence of a dry summer throughout the state results in the prevalence of "Xerophytes," *i. e.*, plants adapted to withstand long periods of drought.

4. The remarkable range of conditions, *i. e.*, temperature, rainfall, elevation, soil, etc., results in a variety of vegetation equalled in very few parts of the world.

5. The principal botanical regions are: (1) The coast flora, (2) the redwood forest belt; (3) the valleys, (4) the mountain region of the Sierra; (5) the deserts of southern California.

6. The plants of California show two distinct types; a southern flora of Mexican origin, and a northern flora more nearly related to the vegetation of the northeastern states. These two floras mingle in the central part of the state, the northern forms following the mountains southward, the southern types mainly occupying the valleys. There is a slight infusion also of Asiatic types from the north.

The Rôle of Physical Features in Determining the Distribution of Plants: FORREST SHREVE, Department of Botanical Research, Carnegie Institution of Washington.

The Chapparal and Its Habitat (illustrated): W. S. COOPER, Stanford University.

The broad-sclerophyll vegetation of the Pacific coast, as a dominant type, is confined to the region in which the long dry season, characteristic of the California climate, is combined with low total precipitation and absence of summer fog.

The broad-sclerophyll vegetation comprises two formations: (1) the Oak-Madroña Formation—true forest; and (2) the Chaparral—bush or scrub. Each is subdivided into various associations, the subdivisions being different in different parts of the state.

In the Palo Alto region the Chaparral includes (1) the Adenostoma Association and (2) the Arctostaphylos Association. The former is found

upon south slopes and summits, the latter upon gentle north slopes; and the Oak-Madroña Forest on steep north slopes and in ravine bottoms.

Measurements of evaporation, soil moisture, and soil temperature were made covering a period of eighteen months to determine the habitat differences to which these vegetational differences are due. It was found that the evaporation rate was greatest on summits and south slopes and least on north slopes, as would be expected, but that at the top of the vegetation the differences in evaporation between the aspects were slight. Greater differences were found at the surface of the ground. As to soil moisture, a great difference was found between the two slopes during the rainy season, but this difference gradually decreased during the dry season, almost disappearing at its close.

The conclusion of the study is that the actual physical habitat differences between north and south slopes, though perceptible, are slight, and that evaporation is the fundamental factor. The striking differences seen in the evaporation rates at the surface of the ground, in the soil moisture on the two slopes and at different times of the year, and in the soil temperatures, are due in very large part to the reaction of the vegetation upon the habitat.

Discussion: Abrams and Clements.

Distribution of Cacti with Reference to the Rôle Played by Root Response: W. A. CANNON, Department of Botanical Research, Carnegie Institution of Washington.

In southern Arizona the roots of the cacti lie relatively close to the surface of the soil and are subject to the maximum temperature changes, including the highest temperatures of the summer season. Experiments show that a relatively high temperature of the soil is necessary to the best root growth of the cacti. Owing to the arid fore-summer in southern Arizona such root growth takes place in midsummer only, when the seasonal rains come. Since active growth does not occur in the colder portions of the year, although the soil may be moist, the possibility is suggested that the cacti as a family are mainly limited to such regions as have summer rains, other conditions being favorable.

A comparison of the climatic conditions of those portions of America, where the cacti form a prominent portion of the flora, shows that as a matter of fact, they agree in this, that rains are characteristic of the warm season. On the other hand, in regions otherwise apparently favorable, the cacti are either wholly wanting, or they constitute only an insignificant part of the flora.

Climatic Cycles and Succession: F. E. CLEMENTS, University of Minnesota.

Discussion: Abrams, Cooper, Eastwood.

The Diversity of Ecologic Conditions and Its Influence on the Richness of Floras: JOHN W. HARSHBERGER, University of Pennsylvania. (Read by H. M. HALL.)

Ecologic conditions are those which are associated with the environment. They include the influence of climate, soil, physiography, chronology and the life relations of the surroundings. The influence of these conditions on the richness of floras may be considered statistically. The generic coefficient, which is the relativity of genera and species, is inversely proportional to the diversity of the ecologic conditions. The generic coefficient was worked out for the floras of Point Pelee, Ontario; for the pine-barrens of New Jersey; for Hartsville, South Carolina; for the Altamaha Grit Region of Georgia; for Miami, Florida; for the Florida Keys; for the Upper Susquehanna, Pennsylvania; for Lancaster County, Pennsylvania; for Columbia, Missouri; for Jackson County, Missouri; for the Yosemite National Park, California; for the state of Connecticut; for the state of Pennsylvania; for Alabama; for the central Rocky Mountains; for the state of Washington. It was found that Point Pelee with a simple topograph was at one extreme with a generic coefficient of 74.7 per cent. and the Central Rocky Mountains and the southeastern United States at the other extreme with highly diversified and generic coefficients of 23.9 per cent. and 23 per cent. respectively.

Discussion: Clements, Hall, Eastwood.

Plant Succession in the Palo Alto Region: W. S. COOPER, Stanford University.

The Palo Alto quadrangle comprises two distinct physiographic areas: (1) the mountains, covered mainly with residual soils, and (2) the alluvial slope to the bay and beneath it, composed entirely of transported soils derived from the mountains.

On the latter area there is a very perfect succession of vegetational stages, correlated with the building up of the alluvial slope by stream deposition. The stages are as follows: (1) Algæ, in the shallow water of the bay; (2) Salt Marsh; (3) Composite-Willow Formation; (4) Oak Forest, composed mainly of *Quercus lobata* and *Quercus agrifolia;* (5) *Chaparral,* mainly *Adenostoma.* The Salt Marsh replaces the Algæ soon after the soil surface emerges at low tide. The Composite-Willow formation follows with the elimination of the salt from the soil. The Oak Forest appears when there is sufficient feeding ground

for the tree roots, well aerated, above the water table. The Chaparral follows when the distance to the water table becomes so great that the oaks can not obtain sufficient water. The chaparral is permanent because it flourishes independently of moisture supply from the ground water. This succession thus progresses from halophytic to mesophytic conditions and from thence to xerophytic, the final stage being far less mesophytic than the intermediate ones.

In the mountain area successions are short and indistinct and there will be no climax formation for the whole area, short of base levelling. North and south slopes will differ in vegetation as long as they exist, the present dominant vegetation of each aspect being the temporary climax of a short succession.

Discussion: Campbell, Clements, Eastwood.

The Flora of the Desert Basin of the Mohave: S. B. Parish, San Bernardino.

The topography of the Mohave Desert is complex in contrast with that of the Colorado Desert, which is a simple valley, but the climatic and edaphic conditions are practically identical, and are of a pronounced xerophytic character, and consequently such is the character of the plant population. It is, however, locally modified by intrusions through the passes; by the influence of the Colorado River and very markedly by that of the Mohave River. The distribution of the cacti is found to depend upon the amount and reliability of the rainfall. Some account is given of the vegetation in and about the infrequent springs. Certain differences in the respective vegetations of the Mohave and the Colorado Deserts are noticed and shown to depend upon different emigration currents.

Friday, August 6, 10 A.M.

Some Features of the Distribution of the Marine Algæ of the West Coast of North America: W. A. Setchell, University of California.

Discussion: Clements, Lawrence.

Gas Conditions in Nereocystis: T. C. Frye, University of Washington.

Physiological Conditions in the Large Kelps of the Pacific Coast: G. B. Rigg, University of Washington.

The great size and the rapid growth of the four conspicuous kelps of the Pacific coast as well as their potential value as a source of potash fertilizer and of various by-products makes the investigation of their physiological processes a matter of both scientific interest and economic importance.

The growth of the large kelps *Nereocystis leutkeana, Macrocystis pyrifera, Alaria fistulosa* and *Pelagophycus porra* is rapid. Possible factors in this are (1) mechanical stretching by tidal currents (2) great turgidity due to high osmotic pressure in cell sap (3) abundance of potassium, influencing nuclear division.

There is much more potassium than sodium in kelps while the reverse is true in sea water. Possible factors in this are (1) greater permeability of the protoplasm for potassium; (2) a change of potassium compounds into some other form which does not lower the diffusion gradients.

Workers are not agreed as to the source and composition of the gases in the floats of marine algæ, hence definite conclusions as to their part in metabolism are impossible.

Probably carbon dioxide for photosynthesis comes from either the gas in these floats or from carbonates in water, rather than from carbon dioxide in sea water.

Tidal currents may be a factor in photosynthesis by keeping the fronds at the surface. The kelps produce no starch. Their sugars may be a factor in high osmotic pressure.

Studies on the respiratory ratio in marine algæ throw some light on the materials oxidized in respiration.

This paper contributes (1) a summary of the literature bearing on the physiological processes in the large kelps; (2) some hitherto unpublished data with regard to these processes; (3) some suggestions as to possible interpretations of the available data on them; (4) a statement of the more conspicuous gaps in our information in regard to these processes and of the importance of a comprehensive investigation of them.

The Personation and Multiplication of the Fruits of Certain Opuntias: D. S. Johnson, Johns Hopkins University.

The fruits of some few of the cacti, like those of certain Eucalyptoids, differ from those of most other seed plants in not falling from the tree, at the end of the growing season in which they were initiated by the flower. In the exceptional forms mentioned, of which *Opuntia fulgida* is one of the most striking examples, the fruit remains attached, and growing, season after season.

The primary flowers of the season in *Opuntia fulgida* are formed from the lateral buds, or areolæ, of the last year's branches and also from areolæ of the persistent fruits of former seasons. These primary flowers shed the perianth five or six days after the opening and give rise to fruits, which not only remain attached but also give rise, sometimes even before the flower has opened, to

the buds of secondary flowers. The latter in turn bud out Tertiary ones and these initiate flowers of a fourth generation, by the middle of July. All of the four, or more, generations of flowers formed in a season, remain attached and growing for several seasons. In each succeeding season any fruit of the first season's series may give rise to a similar set of primary, secondary, Tertiary and Quaternary fruits. In this way clusters of a hundred fruits, including from ten to fifteen generations, may be formed.

If these persistent fruits remain attached they give rise only to flower buds. If they are broken off and placed on moist soil the same areolæ develop roots and vegetative shoots, and so start a new plant.

Teratology and Phylogeny in the Genus Trillium: R. R. Gates, University of London.

Trillium is a genus of plants which is in an unstable or mutable condition. Many of its variations are teratological. There are frequent records of double flowers appearing, especially in *T. grandiflorum*. In such cases it appears that the same root-stock continues to produce a double flower year after year. Hence a germinal change must have occurred leading to the production of such a rootstock.

A form related to *T. grandiflorum* and known as var. *variegatum* has been studied in Michigan, the Niagara peninsula and near Syracuse, N. Y. This is exceedingly variable, producing in some cases 10 per cent. of abnormal plants which can not reproduce from seed yet which reappear in large numbers each year. This form frequently has long petioles to the leaves, which suggests that *T. petiolatum*, an unrelated species with long petioles, may have originated similarly through a mutation.

In various species of *Trillium* individuals occasionally appear having a whorl of four leaves and their flower parts in 4's instead of in 3's. This is a generic feature of the related Euro-Asian genus *Paris*. Another peculiarity of *Paris* is the elongated connectives, a feature which is a specific character in *T. decumbens* and occasionally appears in teratological specimens of *Trillium*.

Such facts show that variations tend to follow certain paths or lines of cleavage, and these lines must depend upon the structure of the germ plasm. It would appear that the teratological variations of one genus may, under certain conditions, give rise to the stable condition of a derived genus. The paths of variation in a genus may thus indicate tendencies which have found expression in various related genera.

Morphology, Relationship and Sex-determination in Thalocarpus curtisii: F. McAllister, University of Texas.

The morphology of *Thallocarpus Curtisii* is the same as that of the Riccias with two minor exceptions. The rhizoids lack the peg-like thickenings characteristic of the Marchantiales, and the four spores of the tetrad adhere to form a spore ball as is the case with some of the *Sphærocarpus* species. The gametophyte seems to be the same in structure as the spongy Riccias. The sporophyte has no traces of a foot nor of sterile nutritive or elater-like cells. It is difficult to see how this liverwort was ever included with the *Sphærocarpos* forms.

The four spores of the tetrad form, on germination, two male and two female plants. In this respect there is a similarity to *Sphærocarpus Texanus* and *S. Californicus*.

Quasi-experimental Formation of Æcidia in Cotton Leaves: F. E. Lloyd, McGill University. (Read by title only.)

Small plants of cotton were grown in 3-inch pots for over one year, and subjected to severe physiological drought, moderated sufficiently to keep them alive. Plentiful watering, aided by rising temperatures, resulted in forcing growth in many lateral shoots, and these produced a large proportion of abnormally shaped leaves. The whole series presented a variety of shapes, the simplest showing a mere constriction across one or more lobes. Foldings, lobulations and concrescences entered in to accentuate the departure from the normal, which, passing through stages with ill-formed and only partially separated ascidia, culminated in perfect ascidia raised on their proper petioloid supports.

Such abnormalities appear to rise from identical conditions with fasciations and indeed both these kinds of aberrancy are found associated in the same plant (*Fraxinus, Spinacea*). They have been shown to be inherited in some cases.

Desiccation and Starvation of a Succulent: D. T. MacDougal, E. R. Long, J. G. Brown, Dept. Bot. Research, Carnegie Inst. of Wash. (Read by title only.)

A number of large sound individuals of *Echinocactus*, and of several joints of *Opuntia* were deprived of water supply, and compelled to carry on existence at the expense of accumulated water and food-material. Some of the preparations were exposed to the full illumination to which they were accustomed, and others were placed in diffuse light obtaining differential effects in water-loss, respiration, disintegration of acids, and photo-

synthesis. The principal generalizations arising from the studies are as follows:

An *Echinocactus* in the open may survive no more than two years at the expense of its surplus food material and water. Similar plants in diffuse light have been seen to be sound after six years of starvation, although the effects were marked.

Non-reducing soluble sugars which are present in only minute proportions if at all in normal *Echinocacti*, are noticeable constituents of the sap of desiccated plants.

Extended desiccation and starvation made no alteration in the integument of *Echinocactus*, but in a plant which had been thus treated for 73 months the cuticle was thicker than the normal, while the outer wall of the epidermal cells was thinner. Cytoplasm and nuclei in the epidermal system were reduced but new cork layers were being formed as in the normal. Division was seen in the epidermal layer at the bottom of the grooves of the stem. The stomata remained permanently open and many were in a collapsed condition. Guard cells of stomata differed from the normal in having anterior walls thinner as compared with the posterior walls.

The palisade layer was thinner than in normal plants of Echinocactus. The cytoplasm was reduced to small masses in the angles of the cells, and the nuclei were variously deformed and reduced in size. Vacuoles had disappeared from the nucleoplasm and a thickened granular layer was present in the peripheral portion.

The most pronounced effects of desiccation and starvation were exhibited by the cortex of *Echinocactus*. The changes noted as having been seen in the palisade tissues were followed by the entire disappearance of the protoplasts and the hydrolyzation of the cell masses formed lacunæ as large as 8 cubic centimeters.

On Wednesday, August 4, Section G and the Biological Society of the Pacific held a dinner at the Hotel Sutter, San Francisco.

W. J. V. Osterhout, *Secretary*

SOCIETIES AND ACADEMIES

BIOLOGICAL SOCIETY OF WASHINGTON

The 544th meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club Saturday, November 6, 1915, called to order by President Bartsch, with 90 persons present.

On recommendation of the council, Gilbert F. Bateman, Trinidad, Colorado, was elected to active membership.

The first paper of the regular program was by O. P. Hay, "A New Pleistocene Sloth from Texas." Dr. Hay discussed the finding in Texas of a new member of the genus *Nothrotherium*. This discovery extends the range of the genus from South into North America. The specimen was exhibited and remarks were made on the interrelationships and distribution of the living and fossil American Edentates.

The second paper was by J. N. Rose, "Botanical Explorations in South America." Dr. Rose gave an account of his botanical explorations in South America. He outlined first the field work which he and Dr. N. L. Britton had planned in connection with the cactus investigations of the Carnegie Institution of Washington and then proceeded to describe the great cactus deserts of South America which he had visited. During his last trip to South America he spent six weeks in the state of Bahia, Brazil, six weeks in the state of Rio de Janeiro, Brazil, and three weeks in Argentina. Large collections were obtained. Many living plants were sent back to the United States for cultivation. The living collection is now on exhibition in the New York Botanical Garden. Several remarkable generic types of cacti were discovered. Dr. Rose's paper was illustrated by numerous lantern slides of regions visited, of cacti in their native environment; and by many interesting botanical specimens.

The last paper of the evening was by Dr. L. O. Howard, "Some Biological Pictures of Oahu (Hawaii)." Dr. Howard showed a large number of lantern slides from photographs made by him during a short stay the past summer on the island of Oahu. Special emphasis was laid on those which dealt with agricultural problems and economic entomology, many of which are peculiar to the Hawaiian Island.

M. W. Lyon, Jr.,
Recording Secretary

THE NEW ORLEANS ACADEMY OF SCIENCES

The regular meeting of the academy was held in Tulane University on Tuesday, November 16, 1915, Dr. Gustav Mann, president, in the chair.

The paper of the evening was by Dr. W. H. Dalrymple, of the Louisiana State University, on "The History of the Cattle Tick Fight in Louisiana." Dr. Dalrymple gave a brief history of the fight in Louisiana, first, by individual effort, then by state effort, and, finally, by federal aid. The paper proved of considerable interest and there was much discussion at the close.

R. S. Cocks, *Secretary*

SCIENCE

Friday, December 24, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE RELATION OF THE ACADEMY TO THE STATE AND TO THE PEOPLE OF THE STATE[1]

We are celebrating the twenty-fifth anniversary of an institution whose existence is unknown to the great majority of the people of Ohio. Yet it has enjoyed a prosperous life of a quarter of a century during which it has held many meetings in different parts of the state. At these meetings important results of original research on the part of its members were presented, many of which have been published by the academy and in various scientific journals, thus becoming a part of the great store of learning which the world is accumulating.

The academy can not be fairly charged with undue exaltation of its own merit or importance in the past and, as an incorporated institution of the state it has a right to think that some consideration should now be given to the relations which it might and should sustain to that state and to the people of the state.

As a preface to such consideration it seems desirable to refer to the views of a few persons who would naturally be among its most active supporters did they not believe that under present conditions there is no good reason for the existence of such a society as the Ohio Academy of Science, contending that other organizations of a similar character, mostly national in their scope, offer as good or better facilities for the accomplishment of the principal ends the academy has in view. There is enough ground for such a contention to justify a reply.

Of the many remarkable social evolutions

[1] Address at the celebration of the twenty-fifth anniversary of the Ohio Academy of Science.

that have marked the last quarter of a century none is more curious and interesting than the marvelous increase in the number of societies or groups of people associated together for some special purpose other than what is generally known as "business." It seems to be an accepted theory that if any thing is to be done or ought to be done it is only necessary to form an organization of those who think it ought to be done, after which it is often assumed that in some mysterious way the thing will do itself. There is no part of the country however remote or difficult of access that has not been penetrated by and permeated with this malady, and clubs, associations, circles, etc., have been formed in bewildering numbers and perplexing confusion as to origin and *raison d'être*. Persons cynically inclined have attributed this to the fact that each organization requires a president and other officers and that the universal desire for place-holding is thus gratified. While there is doubtless more truth in this explanation than we would care to acknowledge, the phenomenon is largely the outcome of the modern drift towards specialization in all spheres of human activity. Indeed it is more than a drift; it is a veritable flood-tide and many organizations of recent creation are examples of specialization gone mad.

Scientific men have not escaped this epidemic and during the past twenty years their segregation into groups each of which confines its activities in study and research to a special and often a very narrow field, has gone on with alarming rapidity. Alarming because while there can be no question that science has been and will continue to be greatly advanced by specialization it can not be denied that the man of science has suffered and will continue to suffer from the same cause. Burrowing in a trench, necessary as that operation often is, if persisted in to the exclusion of other occupations, deprives the burrower of that breadth of view and general acquaintance with the topography of the surrounding country which is necessary to the understanding, direction or control of larger operations. It will be admitted that up to the present time the epoch-making generalizations in science have originated with men, who, though profound students of some great subdivision of human knowledge, have not been given to acute specialization. Although we may not expect another Bacon to rise and declare, "I have taken all knowledge to be my province," it is safe to predict that if we are to have in the future discoveries of a magnitude comparable with that of the Copernican theory of the universe, the law of gravitation, the doctrine of evolution or the conservation of energy, they will come from men whose learning is comprehensive rather than intensive. Indeed the same rule must hold in more restricted fields of research. One who devotes himself exclusively to the study of "the abdominal parasites of the white ant" is not likely to evolve from it a new and important biological principle; nor is it probable that an intensive study of conjugate systems of space curves or years devoted to a revision of the atomic weights of the rare metals would carry one far on the way towards an explanation of the nature and cause of gravitational attraction. I would much regret to be understood as deprecating or disparaging specialization in science. It is of the highest importance even in its narrowest phase for through it the phenomena of nature are revealed. But finding how one phenomenon is related to another; the logical grouping of results of observation and experiment and the derivation therefrom of general principles and laws will always call for intellectual powers of a distinctly higher order.

I conclude, therefore, that an organization like the Ohio Academy is of prime importance to science in Ohio because it is essential to the proper and complete development of the man of science. By mingling with those whose explorations of the mysteries of nature are directed along lines diverging greatly from his own he is better prepared to estimate correctly the comparative and the absolute value of his own work. He has also an opportunity to familiarize himself with methods and instruments of research used in other departments of science which he can often summon to his own service with great profit.

In our own National Academy of Sciences there is no division of members into sections in sessions for the presentation and discussion of scientific papers. Communications of the most diverse character are presented before the entire body and this course is highly commended in a recent volume by Dr. George E. Hale, which is a study of the academies of all nations and their relation to the progress of human knowledge.

Unfortunately the history of scientific organizations in this country during the past quarter of a century shows a strong movement in a direction contrary to that which I have suggested as desirable. Forty years ago the American Association for the Advancement of Science was divided into two sections, one of which included those members who were most interested in the so-called "exact sciences," mathematics, astronomy, physics and chemistry, while the other was made up of students of the "natural history sciences." During the week or ten days of its annual meeting there were daily morning sessions in which both sections participated and there were frequent evening meetings at which addresses and lectures were given by eminent scholars representing both grand divisions of science, each chosen for his skill in presenting his subject in such a way that it was intelligible and interesting to members who were on the other side of the dividing line. In this way the mathematician or physicist might always have a fairly correct knowledge of the more important developments or the larger generalizations in biology or geology. The doctrine of evolution, which came first from that side, was quickly appreciated by students of exact science to which it has since been profitably applied. They, in their turn, gave to the naturalists the great principle of the conservation of energy, of which great use has been made in the study of life in its various forms. The psychological effect of the mingling of these two rather diverse elements of the scientific body was also of great value, and there is not the slightest doubt that both were greatly benefited.

In this bi-partite classification of its membership the association had followed the example of its English forerunner in a practise which the latter still maintains. In the American Association the disintegration began about thirty years ago and at present it is divided into twelve sections.

In addition to this specialization within the largest scientific body of the country, during the past twenty years an astonishingly large number of other scientific societies have come into existence, each of which is specially devoted to a particular department or, more often, to a subdivision of a particular department of science. Indeed the pressing need of the hour is the organization of a Society for the Prevention of the Organization of Other Societies.

Perhaps the most deplorable consequence of this minute subdivision in the ranks of scientific men is that, because of habitual isolation from all not familiar with its technical vocabulary little or no effort is made by one group to translate the

results of original research into a language intelligible to any or all of the others. In spite of the sensational vaporizing about scientific men and scientific discoveries that abounds in the Sunday newspapers and fills the pages of popular magazines, it is absolutely true that at the present day there are *almost no attempts to popularize science*, that is by men who know what they are talking about. A great journal which for half a century was devoted to the exposition of the results of scientific investigation in the vernacular common to educated men has recently been compelled to suspend further publication for lack of support. It seems to be a case in which both producer and consumer have disappeared.

The Ohio Academy of Science is organized in such a way as to afford, it is hoped, an effective check upon this unfortunate tendency. In its sectional meetings opportunity is offered for the discussion of results of research of the most specialized character, while in its general sessions the more important of such results, when finally accepted, may be presented in a manner intelligible and interesting to all. As an illustration of the latter possibility I may be allowed to refer to the great pleasure and profit with which, as one whose intellectual horizon has always been regretfully restricted, I listened at the last meeting of the academy to a most able, interesting and instructive summary of work done in the suppression of the foot and mouth disease.

I think it fortunate that the academy is never likely to be very great in numbers. Let us hope that there will always be at least one institution whose excellence is not to be measured by a numerical standard.

The American Association for the Advancement of Science with its ten thousand members, its twelve sections and its twenty-three affiliated societies, all meeting at one time and place, is an aggregation of parts not very closely related. It no longer affords, as in the early years of its existence, a great opportunity for that commingling in social and scientific intercourse which counted for so much in both pleasure and profit for its members. The smaller, specialized national societies take its place in large measure in this respect, but these fail in one most important particular. In them a man mingles with his kind; it is mingling with the other kind that he often most needs.

Finally, the Ohio Academy, being a state institution, should appeal to all residents of the state who are interested in the advancement of science or the promotion of scientific discovery. The geographic compactness of the state and the network of transportation lines by which it is covered makes it easy for all to attend its meetings, wherever they may be held, while the national societies are usually in session at such distant points that the burden of expense and time makes them impossible for many.

The academy, therefore should be accepted as a very desirable, indeed necessary adjunct to the scientific activities of the state and it is entitled to the loyal support of all residents of the state, especially of those who are actually engaged in scientific work.

Let us now consider its relation to the state under which it enjoys a corporate existence. In answer to the question "What has the state done for the academy?" a single sentence will suffice. A quarter of a century ago the state gave the academy its charter, in payment for which it received the sum of five dollars; about two years ago when the academy desired to correct a slight and hitherto undetected error in its name as recorded in the charter the state graciously allowed one word to be

stricken out, receiving for the stroke another payment of five dollars. That is all. It is not known that the state has in any other way recognized the existence of the academy.

In nearly all enlightened countries there is an organized body of scientific men, existing under a charter which gives it at least a quasi-official standing and the scientific knowledge or technical skill of its members is assumed to be at the service of the government whenever in legislative, administrative or judicial proceedings scientific problems are encountered. In England there is the Royal Society; in France the Academie Française; in Italy the Reale Accademia dei Lincei—the "Royal Academy of the Lynx"—of which Galileo and Colonna were early members, and in the United States we have the National Academy of Sciences, which, though not yet utilized by the national government as completely as would be desirable, has furnished the material on which some of the most important and far-reaching legislation of Congress rests. By the terms of its charter the government may call upon the academy to "investigate, examine, experiment and report upon any subject of science or art." The actual expense of such service is to be paid by the government, but members receive no compensation. In some states of the union in which there are chartered academies of science a similar relation exists and state governments have greatly benefited thereby, but in Ohio the state government has never yet asked its academy to "investigate, examine and report" upon any subject of science or art. This apparent lack of appreciation of the merits of the academy and the possibilities of its usefulness must be attributed to an indifference or ignorance on the part of state officials for which the members themselves may be largely responsible. Believing that it has thus far failed in this, one of its most important functions, I shall dwell a little on what I conceive should be its proper relation to the state in this respect.

I would have the academy act, through its properly constituted committees, as the adviser and counsellor of the state in all matters relating to science or the arts. The necessity for such advice and counsel is becoming more and more evident every year because the sciences and the arts are every year playing a more and more important part in all things affecting the well being of both the state and the people of the state. Eager to secure the benefits of applied science, state and municipal governments as well as private individuals have been guilty of wasteful extravagance in their unreasoning haste to do good to themselves before they know what really is good. During the past few years we have expended many millions of dollars in the building of what we hope will prove to be good roads. Bad grades, lack of drainage, collapsed foundations and crumbling bricks already show that in many instances we shall be grievously disappointed. That the greater part of the enormous loss resulting from such failures might have been avoided is apparent to any one possessing even a slight knowledge of the principles of highway construction.

Several years ago laws were enacted affecting the sanitation of our dwellings and public buildings, fixing in great detail the methods by which connection shall be made with public water supply, sewers, etc. These were supposed to be in the interest of the individual as well as that of the community at large, as a protection against the spread of disease, and the importance of many of them can not be denied. But within a few years it has been proved that many of the restrictions put upon us by our boards of health are quite useless and

unreasonable. We now know that sewer gas is not poisonous and that much of the cost of a system of so-called "sanitary" plumbing may be avoided, as is already done in countries where legislation follows information in such matters. As our sanitary legislation is much of it largely in the interests of a trade union it is rigidly enforced and the unnecessary burden upon the people is by no means light.

Much the same may be said of our laws and regulations relating to the ventilation of school and other buildings. They add greatly to the cost of construction and maintenance but they are far from being in accord with the more recent results of scientific investigation.

The people of Ohio pay, annually, many millions of dollars for a commodity for the measure of which, as it passes from producer to consumer, the state has made no provision whatever. The assumed honesty of the producer is the consumer's only protection.

Many other examples of wastefulness and burdensome legislation and administration might be cited, but these alone, resulting in a single year in a loss many times enough to endow an academy of science in perpetuity, should be convincing evidence that there is great need of wise counsel whenever laws relating to the applications of scientific discovery are under consideration by a legislative body whose members must of necessity be largely ignorant of the basic principles involved.

It will probably be suggested that the state already has at its command a body of scientific and technical advisers in the several faculties of the state universities and that these, being already in its employ, can more appropriately be called upon for service. But there are numerous other institutions of learning, in the faculties of which are to be found men of high scientific attainments and great technical knowledge and skill, men who are recognized by the members of the State University faculties as their peers in every respect, and the state should be glad to be able to avail itself of their accomplishments. Besides these, with whom science or technology is a profession, there will always be other citizens of Ohio (and may their tribe increase) who, though not connected with any educational institution, are lovers of learning and successfully engaged in research in some department of science. Their knowledge and experience may also be made available through the academy, of which they are almost certain to be members. Aside from the fact that the academy will constitute a much larger group than the faculties of the state universities from which expert counsellors may be chosen there can be no doubt that its advice would always have a higher value on account of its independence of action and freedom from political control or legislative influence. Even college professors are not wholly exempt from the weaknesses of human nature and conditions might arise in which it would go hard with them to oppose in report or recommendation a strong movement of the majority of a body of men to whom they must look for appropriations necessary to their continued existence. Instances in which such influence was successfully exerted would be, of course, extremely rare, but suspicion of its presence might be much less so.

There is a weakness in the third of the three great divisions of our governmental system which has long been deplored by all thoughtful people, to the cure of which a state academy of sciences might make a large contribution.

I refer to the use, or rather the abuse of expert testimony in courts of law. Such testimony is generally summoned in trials in which questions arise involving some de-

partment of science or some one of the technical arts. It must be frankly admitted that the scientific expert himself is responsible, more than any one else, for the humiliating fact that courts and juries often have little respect for him and little confidence in the evidence which he furnishes. This unfortunate and unnatural condition is the result of a system which is a disgrace to all who are responsible for it. The scientific expert has allowed himself to become an advocate. All of his tests, experiments and investigations are made to bolster up a particular theory. Phenomena or results of experiments that tend to discredit this theory are excluded from his testimony unless brought out by the skillful questioning of the attorney on the other side, who has been coached by another expert whose tests, experiments and investigations have been made for the purpose of breaking down this particular theory or establishing a different one. Often both of these men know the real truth of the controversy and if locked up in a research laboratory or isolated from outside influence would come to substantial agreement as to every important fact bearing upon it, for two trained observers can never differ long as to the phenomena present in any investigation.

But they have discredited themselves and the great body of scientific men whom they temporarily represent by selling their services as advocates rather than as experts skilled in ascertaining facts.

It has long been recognized that the remedy for this evil lies in the selection of expert witnesses by the court. Attorneys on both sides should be allowed to suggest questions to the court for the experts to answer if the court considers them proper but never to examine or cross-examine the witness directly. The compensation of the witness should be fixed by the court and paid by the state. The court would often find the academy the best source of information regarding the qualifications of experts and would gladly transfer to it the responsibility of making a selection, precisely as some years ago the officers of our national government charged with the administration of the internal revenue laws shifted the responsibility in an important case to the National Academy of Sciences and adopted the recommendations of its committee.

During the past few years there has been much talk (and not much besides talk) about the importance of conserving our national resources, state and national. I need hardly say that the membership of the academy includes men who have studied these resources for many years; who are better informed regarding them than any or all others. Whenever the state shall seriously undertake legislation to secure their conservation it will be a reckless administration that does not apply to them for advice and counsel.

At the risk of being charged with grossly exaggerating the merits of my fellow academicians and others of their kind I venture to refer to one other function of our complex social and industrial life for which I have long thought to be especially well fitted, those men who are thoroughly trained in scientific methods and who have shown their capacity for the original investigation and solution of difficult scientific problems. I mean for service as arbitrators, especially in those cases in which both sides declare there is nothing to arbitrate, each believing, often with perfect sincerity, that his own position is absolutely right and the other absolutely wrong.

Arbitration, in theory the best method of settling disputes, in practise has more often failed than not. It could hardly

be otherwise under the prevailing system. The ordinary procedure is for each side to choose a representative, generally a lawyer, who is pledged to do his best as an advocate, not as a judge. These two after much difficulty, and sometimes by the tossing of a coin, select a third who is often secretly known to favor one side or the other and thus the case is won before it is begun. In the more favorable case of the third arbitrator being open minded and anxious for a correct decision, the points in dispute are confused and obscured by the pleadings of his legal colleagues whose trade is "to make the worse appear the better reason."

In their place put men who have had much training and long experience in discriminating between appearances and realities, whose life work is the ascertainment of facts, the discovery and announcement of truth regardless of consequences, and arbitration would no longer mean a mere temporary expedient or an illogical and unsatisfactory compromise.

Much of the history of modern civilization might be summoned in support of my contention that training and discipline in the methods of scientific investigation may be depended upon above all other processes to give men power to distinguish between the true and the false; to analyze and reconcile confusing and contradictory evidence, and to extract therefrom whatever of truth it may conceal. For such men are guided by the sentiment that inspired Galileo when, in speaking of the Copernican system of the universe and other scientific doctrines which the Pope had condemned he had the courage to say:

while there can be no doubt that his holiness has absolute power either to admit or condemn, *it is not in the power of any creature to make them to be true or false otherwise than in their own nature and in fact they are.*

Omitting further consideration of the many ways in which the academy might serve the state, and ignoring entirely the intrinsic value of contributions to science which its existence might make possible, I must refer briefly to the reciprocal obligation of the state to the academy.

In the beginning the question was asked, "What has the state done for the academy?" and the answer was, "nothing." My answer to the question what *should* the state do for the academy is almost as brief. It is, "not much." Its usefulness to the state will depend largely on its being free from state control or departmental influence. At the same time their mutual relations should be close enough to justify the state in calling upon it at any time for services of the kind I have indicated. The provision in the charter of our National Academy already quoted seems to be quite satisfactory. In return for services which in time will become both numerous and valuable the state should do two things for the academy. It should undertake the publication of its annual reports, including monographs, memoirs and other contributions to its proceedings which are judged to be of sufficient interest and importance to the people of the state. This is already the practise of several states in which academies of science flourish and it is done by the national government for the National Academy. It should also provide a suitable building in which the regular meetings of the academy could be held, where its archives and collections could be stored and where its special committees could hold their meetings and prepare their reports. This is certainly a modest demand if the members of the academy pledge themselves in return to give to the state without cost, in the form of advice and counsel, the full benefit of their scientific training and technical skill.

During the past few years in public and private speech, in books, newspapers and magazines the word "efficiency" has been heard and seen almost *ad nauseam*. The better the horse the more we are inclined to ride it to death, but that phase of the meaning of this word which implies making full and economic use of all our varied resources must in the end enjoy a useful survival. From the awful calamity which has fallen upon the world in the form of a general European war there are many lessons to be learned, not the least important of which is to discover the origin and cause of the marvellous efficiency of the military forces of one of the great nations involved, or rather, of the people of that nation, or still more accurately, of the nation as a whole, which has displayed a capacity for the immediate and complete utilization of every available resource, animate and inanimate, that has commanded the admiration of even its most bitter foes.

For one of the principal sources of this efficiency we have not far to look.

In 1893, when every nation of the world was collecting the best examples of its material resources and industrial products for exhibition at the great World's Fair held at Chicago in celebration of the four hundredth anniversary of the discovery of America, an old man in Berlin was commanded to present himself at the Royal Palace for an interview with the Emperor of Germany. To him spoke the Kaiser, saying:

> We are sending to America the finest products of our factories, our mills, our fields and our mines; some of our choicest works of art will be there, but above all of these Germany is most proud of the men she produces. You are the best we have and you must go to represent us.[1]

The man thus addressed was not a field marshal of the German army, or an admiral of her navy, her most famous diplomat or her richest iron-master. He was Herman Ludwig Ferdinand von Helmholtz, Germany's greatest natural philosopher, at once the most versatile and profound scholar of the nineteenth century.

The incident is well worthy of our attention as a striking illustration of the value which is set upon men of science and their work by the German Empire. During the past fifty years no other nation has so encouraged scientific research and by no other nation have scientific discoveries been so readily accepted and so quickly utilized. In all legislation upon economic questions the man of science has had paramount influence, and in that greatest of all economies, the prevention of unnecessary waste and the getting out of every material thing the last drop of usefulness, the Germans, from prince to peasant, have no rival.[2] The administration of her municipal governments is a model for the rest of the world, because the advice of the scholar has been sought at every turn. All of her foremost industrial enterprises have had their beginning in the laboratory. In many important lines she has controlled the markets of the world, not on account of her su-

[1] This is no imaginary interview. I have given as nearly as possible the exact words used by Baroness von Helmholtz in telling me of it afterwards.

[2] A personal experience, amusing but instructive, may be worth relating. While living in one of the largest cities in Germany I ordered a suit of clothes from a good shop on one of the principal streets. On the first trial of the coat I failed to find the small "change" or ticket pocket usually on the right side. When I called attention to its absence the tailor showed me that it had been put in on the *inside* of the larger pocket below, explaining that if he put it where it is usually placed by American or English workmen it would be *impossible to have the coat turned,* as the cut in the cloth would then show on the left side! And when I expressed my preference for the usual location he remarked, "Nearly every gentleman in Germany has his coat turned once."

perior business or commercial intelligence but because of the knowledge and technical skill of her chemists.

Whatever we may think of the outcome it can not be denied that it is *applied science* that has enabled the German Empire to suddenly convert itself into a huge engine of destruction, all parts of which seem to have been so delicately adjusted to each other that the awful strain to which the whole is now subjected is distributed among the several members in exact proportion to their ability to bear. Other nations are learning this lesson in the hard school of experience and they are paying tuition in blood and treasure.

Fortunately for us it may be learned by observation as well as by experiment.

T. C. MENDENHALL

November 9, 1915

HISTORICAL SKETCH OF THE OHIO ACADEMY OF SCIENCE

TWENTY-FIVE years ago the first decisive steps were taken looking toward the organization of an Ohio Academy of Science. At the annual meeting of the Biological Club of the State University held November 3, 1891, the retiring president made a short address in which he said substantially: There is need of one institution in Ohio to the organization of which our club should direct its combined energy and influence. This is a state academy of science. If local clubs and societies of science are beneficial, the reasons that make them so apply with greater force to a state organization. Who can estimate the inspiration, the stimulus to research and investigation, that such an institution would provoke? In a great agricultural state like Ohio, a deep, abiding and constantly growing interest will ever be taken in the sciences of geology, botany and chemistry, for these constitute the very foundation, the body and bones, of any rational basis of practical knowledge regarding soils and the various crops that grow thereon. But our State Academy would not be confined to the sciences that relate so directly to soils and crops. All branches of biology, as well as physics, chemistry, mathematics, anthropology, meteorology, economics, sociology, etc., everything that contributes to the sum total of scientific knowledge, should find a place. The initial steps toward the founding of such an academy should be taken by this club, and to-night. This can be done by the appointment of a committee, which should energetically push the matter by preparing a program for a meeting, and issuing a call to all interested, to assist in the organization. In pursuance with this declaration the club appointed a committee consisting of D. S. Kellicott, W. A. Kellerman and the speaker to take such measures as in their judgment were deemed best to carry into effect the wishes of the Biological Club.

The committee soon secured the promise of hearty cooperation from many of the most prominent scientists in Ohio, and issued a call for a meeting to be held in Columbus, December 31, 1891.

The meeting took place at the date named, and appointed a committee on organization consisting of W. A. Kellerman, of the Ohio State University; E. W. Claypole, of Buchtel College; and Henry Snyder, of Miami University.

While the committee just named were preparing a constitution and by-laws, papers were read by Dr. A. M. Bleilie, E. E. Bogue, J. M. Bradford, H. E. Chapin, H. J. Detmers, W. A. Kellerman, D. S. Kellicott, H. A. Weber, W. C. Warner and A. A. Wright.

After the adoption of a brief but comprehensive constitution and a few simple by-laws, the organization was completed by the election of the following officers to serve the

first year: President, E. W. Claypole, Buchtel College, Akron; Vice-presidents, A. A. Wright, Oberlin, and Ellen E. Smith, Lake Erie Seminary, Painesville; Secretary, William R. Lazenby, Ohio State University, Columbus; and A. D. Selby, Treasurer, Columbus, Ohio. Elected as members of the Executive Committee were E. T. Nelson, Ohio Wesleyan, Delaware, and A. D. Cole, then of Denison University, Granville. It should be noted that of the seven elected officers only two, the secretary and treasurer, were residents of Columbus, and connected with the state university. I mention this to show that from the very outset, the academy has been a state-wide institution and in no way restricted or limited to any one section of the state. Attention is also called to the fact that the charter members of the academy, fifty-nine in number, included mathematicians, chemists, physicists in generous proportions.

It was also quite representative of the educational institutions of the state that were interested in science. Besides the state university which naturally had the largest number, the following universities and colleges were represented: Buchtel, Cincinnati, Denison, Miami, Mount Union, Oberlin, Ohio, Ohio Wesleyan, Otterbein, Starling Medical, Western Reserve and Wilmington. Lake Erie Seminary and the State Experiment Station, as well as the high schools of Alliance, Cincinnati, Cleveland, Columbus, Chillicothe, Dayton, Defiance, Geneva, Kent, Portsmouth, Sandusky, and Tiffin were likewise represented.

At the first meeting the secretary was instructed to secure articles of incorporation, and to publish the constitution and by-laws, together with a list of the officers and members.

In accordance with the above instructions, a certificate of incorporation was duly filed with the Secretary of State on March 12, 1892. This certificate bore the following names as incorporators of the Ohio State Academy of Science: W. A. Kellerman, F. M. Webster, A. D. Selby, W. C. Werner, E. E. Bogue and W. R. Lazenby. Of these incorporators Professors Kellerman and Bogue have passed away.

The academy held its first field meeting in Summit County on June 3 and 4, 1892, the headquarters being at what was then Buchtel College, in the city of Akron.

The program for the field-day included an excursion by steamer to Long Lake, and the day was spent in and about the attractive "Lake District" of Summit County. The botanists observed the rich and varied plant societies of the swamps, and the geologists were interested in the great moraines to which, in part at least, the swamps, ponds and lakes owe their origin. In the evening a reception was held in the gymnasium of Buchtel College, at which the visitors were welcomed by the mayor of Akron, the president of the college, Dr. O. Cone, and the president of the Akron Scientific Club.

The next day at an early hour the members and visitors set out for Cuyahoga Falls, where they were cordially welcomed. They were conducted some three miles through the post-glacial gorge of the Cuyahoga River.

This excursion was equally interesting and profitable. The geologists and botanists and entomologists improved the opportunity and added to their stores of scientific facts.

After the passing of a quarter of a century, I can look back upon this as one of the red-letter days of my life.

What was called on the program the first annual meeting, although in reality the second, was held in Columbus, December 29 and 30, 1892. At this meeting twenty-five papers were read. The papers were for the most part on some phase of botany, geology

and entomology. Perhaps the most significant action at this meeting was a brief report of the Committee on Publications, which announced that it had selected the *Journal* of the Cincinnati Society of Natural History and the technical series of *Bulletins* of the Ohio Experiment Station, as the official organs of the academy, until better arrangements can be made.

At the close of this second annual meeting, although in reality the end of the first year of the existence of the academy, the total membership was as follows: Annual members 116—of which number 59 were charter members, and one life member, Mr. Emerson McMillin, who at this early day became a generous patron.

Having dwelt in some detail upon the founding and early history of the academy, I shall treat its subsequent career and accomplishments more briefly.

Statistics are usually wearisome, but in the interests of history they can not be wholly avoided.

What may be termed the annual membership of the academy has increased from 59 charter members in 1891 to 234 members in 1915. About one fifth of the membership reside outside of Ohio, and are found in 15 different states, besides the District of Columbia, Hawaii and Canada. The Ohio residents are found in more than 50 counties of the state.

To illustrate the regularity of growth in numbers, the fifth year the membership was 157; tenth, 173; fifteenth, 179; twentieth, 196; twenty-fifth, 234.

As to attendance, one can not speak confidently, for no records have been kept. On the average I should say that one third of the resident membership have attended the annual meetings. As to place, fourteen of the twenty-five annual meetings have been held in Columbus, two in Granville, two in Cincinnati, two in Cleveland, one each in Oxford, Delaware, Akron and Oberlin.

Summer meetings have been held in well-selected places in the following counties: Summit, Hocking, Licking, Erie, Butler, Knox, Montgomery, Franklin, Ottawa and Wayne. Several of these were joint meetings with other organizations. For instance, in Butler County with the Indiana Academy of Science; in Franklin County with the American Association for the Advancement of Science (the summer meeting of 1899); at Put-in-Bay with the Ohio Teachers Association, and in Sandusky County with the same organization. These delightful meetings were held each year for the first ten years in the life of the academy. For some reason, unknown to me, they then ceased. Would it not be well to renew them? As summer schools are now held at many points in Ohio, it might be advisable to arrange a meeting of a day or two with the scientific departments of some one of these schools.

The papers presented during the twenty-five years number 1,124, or an average of 45 for each meeting. The range in number is from 10, read at the first meeting, to 64, read at the fifteenth. At the twenty-fourth meeting the number was 61, and at the twenty-fifth it was 58.

Cloud and sunshine, joy and grief, are common contrasts in our life. We experienced these contrasts at the eighth annual meeting. The first serious break in the ranks of our membership had then occurred. Two of our ablest members were missing. We grieved that Dr. Kellicott had been stricken by death, and that Dr. Claypole had left Ohio to spend the remainder of his days in the more genial climate of California.

At the same time we rejoiced that one who had already proven himself a friend should modestly announce that he had given the academy $250, to be expended in ways best suited to promote scientific research; with the further statement that such a sum

might be given annually, provided the use made of the money was satisfactory and it proved convenient for the donor to spare it. We may assume that these conditions have been fulfilled, for from that day to this, or for eighteen successive years, this generous gift has been received. It has come to us quietly, promptly and without solicitation during all this time.

It has been administered in the same quiet way, and not one penny has been used for anything except to aid in research, or the publication of its results.

The influence of this gift has been as gentle and persuasive as the spring sunshine or summer shower. Nearly a score of special papers have been prepared and published by the academy through its aid. As many more have been published elsewhere. All honor to this scholarly, efficient, large-hearted, high-spirited man. I trust he believes that "the reward of a good deed is to have done it," if not, I don't know how he is to be paid.

We are here to-day in a spirit of congratulation. We congratulate our academy upon what it has accomplished. We congratulate Emerson McMillin on what he has done for the academy.

We congratulate the universities, colleges and high schools of Ohio that so large a number of their instructional force are active workers in our academy. Our annual meetings have confirmed and strengthened a spirit of good will between the educational institutions of the state. They have cultivated the amenities, and developed a feeling of brotherhood among our members. Our academy since its inception has stood for good scholarship, good fellowship and good citizenship. The essentials of a great landscape are unity and variety. These are likewise the great attributes of an association for the promotion of science. Unity in the spirit and ideals of the work to be accomplished, and variety, infinite variety, in the means by which these ideals may be developed. We come together on the basis of commanding interests and diverse experiences. This devotion to the varied phases of science detracts nothing from the pursuit of the older humanities, but adds materially to the effectiveness of any study that puts the student in closer touch with his environment—in closer touch with nature—and nature's law. This spirit was in Orton and Kellicott and Claypole, who were among the founders of the academy. What a fine influence these men exerted! What fine lives they led! It was a happy blending of the strenuous, the simple and the abundant life.

Strenuous, because in addition to the enforced and exacting labors of a teacher were added the self-imposed tasks of the investigator; simple, because they lived close to nature and her laws were the rule and guide of their daily conduct. They had neither time nor means for luxury. And most of all their lives were abundant; abundant in opportunity, abundant in accomplishment, abundant in honors, abundant in friendship. Demanding little, they received much. They are of those who, losing their lives, save them.

We are together to celebrate an epoch, not alone in the promotion of science, but in the attainment of the ideals of education; ideals for which the academy will stand in the future as in the past.

William R. Lazenby
Ohio State University

THE NAVAL CONSULTING BOARD OF THE UNITED STATES[1]

The so-called "five-million laboratory," proposed by the Naval Consulting Board,

[1] From an address made before the joint meeting of the New York Section of the American Chemical, the American Electrochemical Society, and the Society of Chemical Industry, by Dr. L. H.

has been the favorite subject of varied and picturesque criticisms which, as usual, originated more through lack of information than by ill-will.

Secretary Daniels requested each member to address to him his personal opinion on the advisability of the creation of a research laboratory where urgent technical matters relating to the needs of our navy could be studied successfully.

At the second meeting a special committee was appointed to submit a joint report. On this committee were, besides Mr. Edison, four other members. One of the other members of the committee is a man who has earned a national reputation in organizing and developing one of our largest mechanical industries. The second member is at the head of perhaps the largest and best endowed scientific research institution of the world; another is the chief of one of the most successful chemical and physical industrial research laboratories of this country; the fifth has devoted much of his life to private chemical research.

It was interesting to follow how the five members grouped themselves in accordance with their own point of view, dictated by their daily scope of action: The chemical or purely scientific members of this committee agreed pretty well on the kind of research laboratory they had in view, and although their suggestions had been written independently without consulting each other, their general recommendations as to the organization, equipment, and needed expenditures were fairly similar and relatively modest.

But their recommendations were mainly limited to a chemical and physical laboratory; they did not include the study of elaborate mechanical and technical problems which go far beyond the questions which are usually dealt with in chemical and physical research laboratories.

The two other members, on the contrary, wanted to prepare thoroughly for engineering problems of immediate importance, the solution of which seems indispensable if the money of the navy is to be spent to best advantage.

They set forth, from their own direct experience, how very expensive such engineering experimental work is likely to be.

Edison, for instance, pointed out the millions he spent in developing some of the details of his inventions; another member identified with the automobile industry stated that one single automobile concern here in the United States had found it necessary to spend half a million dollars in one year for experiments and research.

The modest estimate for a merely chemical and physical laboratory was thus snowed under by the irrefutable evidence of the much larger needs for a suitable mechanical or engineering department.

Of course, it was argued that the Navy possesses already several experimental stations at its different navy yards, and at the torpedo station in Newport, aside from the different testing laboratories for the materials used for ordnance or ammunition; that, furthermore, the excellent laboratory facilities of the Bureau of Standards are available.

The answer to this was that each and every one of the present institutions were more necessary than ever, but were totally insufficient; furthermore, the full cooperation of all of them is needed; all this in view of the fact that, at present, the navy of this country is facing unusual responsibilities.

If it is deemed urgent to be prepared for defense then this defense involves problems the solution of which can not be deferred

Baekeland, member of the board, and printed in *Metallurgical and Chemical Engineering*.

indefinitely. If something has to be done, it must be done immediately—not in five or ten years hence, when it may be too late.

In all of our present scientific research laboratories, time seems of relatively little or no account; problems which can not be solved to-day can be solved to-morrow or in ten years or during the next generations; but this is not the case with the problems connected with the contemplated defense of our country; the solution of these problems can not be postponed. They demand immediate action.

Nor is the condition of our navy similar to that of an industrial concern that can afford to take chances with machinery or equipment which is not strictly up to date, and still show some commercial success. For instance, recent events have demonstrated that there is no use building the best and newest fortresses against an enemy who possesses guns strong enough to demolish everything in existence.

Nor is there any chance of success in using the very best artillery at anything like equal chances if your adversary can do his scouting and range-finding with aeroplanes provided with reliable engines, while your aeroplanes are equipped with motors which give out at unexpected moments.

In our clumsy war with weak Spain, we went into the field with black powder when all other nations, even Spain, were equipped with smokeless powder. Why? Because we had postponed too long studying the chemistry of the subject.

The fact is that if we require a navy at all, our navy can not afford to use anything but the very best and most efficient means of defense. Not to possess the very best might put us in the same absurd condition as the wooden navies of the world were in after our civil war had established the supremacy of the iron-clad vessel.

The contemplated outlay for the navy for the next five years, for new ships, aviation and reserve of munitions, amounts to about $500,000,000. These tremendous expenditures of money, in order to be of real value, ought to be made as efficient as possible. All doubtful and inferior devices must be eliminated by direct experiment, by research and tests, *before* it is too late to remedy them.

This requires accelerated action; in fact, Mr. Edison's personal opinion was that research and laboratory work in this instance "should go on night and day without intermission" instead of the usual easy-going short-day plan followed in laboratories.

If one single automobile concern in the United States finds it to its advantage to spend in one year half a million dollars on testing, research, or experimentation, how much more important is the business of the United States navy, where money not spent wisely is better not spent at all, because then at least we shall not have the illusion that we are equipped for defense, when we have merely lost our money on antiquated devices.

Without mentioning any spectacular problems of modern warfare, it might be stated that such a prosaic detail as the corrosion of condenser tubes of our war ships involves an annual damage of about $2,000,000. If $1,000,000 were spent on research on this problem alone, with the result of reducing the damage to one half the total outlay would be compensated in a few months' time, aside from the important fact that our fleet would be stronger because less of our ships would be unavailable for service.

It was brought out that there was little use in spending so many millions on flying machines as long as there was any doubt on the reliability of their engines, and until an absolutely well-tried and standardized

engine had been developed. To accomplish this experimental work in a period of a few years would cost some money; but to do this rapidly, within a few months, before order is given to build these flying machines, requires enormous outlays of money, alongside of the indispensable engineering talent.

Another member brought out the fact that even conservative industrial enterprises found it necessary and profitable to spend at least 2 to 5 per cent. of their sales on research and experiments. At this rate, the contemplated expenditure of $500,000,000 in five years would certainly warrant an expenditure of at least five million for research during that period.

Money for this purpose, wisely used, ought to do so much good to the navy as to increase its efficiency by the value of several battleships costing considerably more. Mr. Edison's arguments were particularly eloquent when he enumerated the enormous expenditures for research in his own laboratories.

In this discussion everybody seemed to be well in accord with the general idea that whatever expenditures were recommended, the contemplated work should be carried out under immediate supervision of the navy; that this work should not be started all at once—full blast—but should be extended gradually, as fast as circumstances demand it.

In view of all this, two policies were open for obtaining the necessary appropriations—the old time-honored trick of asking from congress first an appropriation of a few thousand dollars, knowing very well that this would be insufficient, then after awhile ask an additional appropriation and keep on nagging and asking at various intervals.

But the members of the advisory board thought it a more honest policy to state the facts as they saw them and to confront the secretary of the navy with the probable maximum expenses for research and experimentation, commensurate to the five years' naval building program now under contemplation. The five-million dollar budget for experimental work to be expended during those five years, or about one million a year, may strike the uninitiated as needlessly large, although it is only about what some industrial enterprises have found necessary to spend on their own experimental work.

But if the nation does not want to go to the expense of developing the latest and most efficient means for defense at the lowest cost by obtaining the necessary information through preliminary experiments, instead of committing mistakes on a large permanent scale; or if our country wants its navy to keep on building its ships or other means of defense, as were good enough in the past, regardless of the fact that modern war requires the very latest and the most efficient available devices, then let us not be astonished if after incomparably more money has been spent for increased armaments, we find that we are loaded with means of defense which have become obsolete in the meantime and are merely good for the junkheap of antiquated equipment.

The foregoing is a brief résumé of various arguments which were submitted by some members of the board, and this is the first time that this discussion has been reported in public. Let us hope that its publication may help to dispel some of the ideas of the public which imagines that the board contemplates the immediate erection of a "$5,000,000 laboratory building, where the members of the Naval Consulting Board can experiment to their hearts' content in company with long-haired inventors."

As Mr. Edison expressed it picturesquely:

"The money should be spent not on buildings, but on a national junkshop," where means of defense can be tried out first, at relatively small cost so as to learn how to get the most and very best for the money, and so as to avoid making expensive and dangerous blunders on a wholesale scale.

SCIENTIFIC NOTES AND NEWS

THE American Association for the Advancement of Science and the scientific societies affiliated with it meet at the Ohio State University, Columbus, Ohio, beginning on Monday, December 27. The program of the meeting has been printed in SCIENCE, and details in regard to the places of meeting and the officers of the different societies that meet during convocation week will be found elsewhere in the present issue of the journal.

WE have not been able to obtain any program of the Pan-American Scientific Congress which meets in Washington for two weeks beginning on December 27. It is possible that after the adjournment of the Columbus meeting of the American Association, the council will call a special meeting at Washington in conjunction with the congress.

THE nineteenth International Congress of Americanists and the affiliated societies, meeting in Washington from December 27 to 31, has an extensive program on which are represented most American anthropologists and a number of foreigners.

THE State Geographical Society of New Mexico was organized in October with David Ross Boyd, Ph.D., president of the state university as president, and Governor McDonald, Senator Catron, Ex-Governor Prince and Professor C. T. Kirk, as vice-presidents.

DR. ERASMUS KITTLER, known for his work in electro-technics, has been awarded an honorary doctorate of engineering by the Darmstadt Technical School.

DR. ALBERT STUTZER, professor of agricultural chemistry at Königsberg, will retire from active service at the close of the present semester.

DR. HUGO FISCHER has been appointed acting head of the chemical and bacteriological department of the Kaiser Wilhelm Department for Agriculture in Bromberg.

KING FERDINAND, of Bulgaria, has been removed from the membership in the Entomological Society of France, which he has held since 1882. His name has also been erased from the membership list of the Petrograd Entomological Society. In this society there has been elected in his place, M. Lameere, of Brussels, who is now working in the Paris Museum of Natural History.

THE Massachusetts Agricultural College at Amherst has sent Professor F. A. Waugh to lecture to the students in landscape gardening at the University of Illinois. In exchange, the Illinois Agricultural College has sent Professor R. R. Root to take charge of the classes of Professor Waugh at Amherst.

DR. CHARLES S. PALMER, formerly professor of chemistry in the University of Colorado, and later consulting chemical engineer for various manfacturing interests in New England, has recently accepted a fellowship in the Mellon Institute for Industrial Research of the University of Pittsburgh.

AT the last meeting of the Rumford Committee of the American Academy of Arts and Sciences, the following appropriations were made: $200 for the purchase of a comparator to be used by Mr. Raymond T. Birge, of Syracuse University, in his researches in spectroscopy. $400, in addition to a former appropriation, to Professor P. W. Bridgman, of Harvard University, in aid of his researches upon thermal phenomena under high pressures. $300, in addition to a former appropriation, to Professor A. L. Clark, of Queens University, in aid of his researches on the physical properties of vapors in the neighborhood of the critical point. $300, in addition to a previous appropriation, to Professor Gilbert N. Lewis, of the University of California, in aid of his researches on free energy.

PROFESSOR BENJAMIN MILLER, of Lehigh University, and Dr. Joseph T. Singewald, Jr., associate in economic geology at the Johns

Hopkins University, have returned from a seven months' tour of South and Central America, bringing with them a valuable collection of ores.

DR. WALTER PENCK, docent for geology at Leipzig, has accepted a chair of geology at Constantinople.

DR. FREDERICK PARKER GAY, professor of pathology in the University of California, has been chosen by his colleagues in the faculty of the University of California as faculty research lecturer for 1916, and will give this annual public address on the results of his own research in some special field at the University of California on the evening of Charter Day, March 23, 1916. His selection was in recognition of his recent work in developing improved methods for the treatment of pneumonia, a new method for the treatment of typhoid fever by the use of a sensitized vaccine, his researches, in collaboration with Dr. Edith J. Claypole, in the field of immunization against typhoid, and his development in association with Dr. J. N. Force of a skin test as to immunity against typhoid.

A SERIES of free public lectures for amateur gardeners and those interested in plant growth has been established at the University of Pennsylvania. The lectures are being given on Wednesday evenings by Dr. John M. Macfarlane, professor of botany and director of the botanical gardens of the university.

PROFESSOR ROBERT A. MILLIKAN, of the University of Chicago, addressed the Washington University chapter of Sigma Xi in St. Louis on November 30 on the subject "Atomism in Modern Physics."

A BUST of Alphonse Bertillon has been unveiled in the Paris Bureau of Anthropometry.

DR. A. ALEXANDER SMITH for many years professor of medicine in the Bellevue Hospital Medical College, and in the combined University and Bellevue Hospital Medical College, died on December 13, in his sixty-ninth year.

DR. ALEXANDER T. ORMOND, president of Grove City College, formerly professor of philosophy at Princeton University and a distinguished writer on philosophical subjects, died on December 18, aged sixty-seven years.

LIEUT.-COL. CHARLES S. BROMWELL, head of the Army Engineer Corps at Honolulu, died by suicide on December 10 at the age of forty-six years. He had served as superintendent of public buildings in Washington and as military aid to President Roosevelt. During the past year he had been in Honolulu, where he was in charge of the engineering work in connection with the improvement of the harbor and the construction of the new breakwater at Hilo.

DR. PETER VOGEL, professor of mathematics in the artillery and engineering school at Munich, has died at the age of fifty-eight years.

DR. FRIEDRICH QUOOS, assistant in the chemical laboratory of the Charlottenberg Technical Institute, has been killed in the war.

SURROGATE COHALAN has upheld objections by Mrs. Lida Pope Colburn to the will of her husband, Richard T. Colburn, on the ground that the laws of the state of New York do not permit a testator whose wife is living to bequeath more than one half of his estate to educational or scientific institutions. He died on December 9, 1914, and left the bulk of his estate of $297,537 to the Carnegie Research Fund [Carnegie Institution of Washington] and the American Association for the Advancement of Science for original research in "physical or psychic demonstrable sciences." Mr. Colburn gave an annuity of $1,200 to his widow, and said he gave her no more "in order not to tempt her into unsound investments, speculations or lures of fortune hunters, charlatans or parasites. A modest scale of expenditure is my injunction to her." The two institutions will divide half the estate and each will receive about $75,000.

AT the annual meeting of the New York Academy of Sciences, on December 20, at the Hotel Manhattan, through the courtesy of the telephone company, there was arranged a somewhat extensive program of communication with the Pacific coast. This included photographs of the line and of its construction, conversation between officers of the California Academy

of Sciences and officers of the New York Academy of Sciences, music at San Francisco, and other demonstrations,—all audible to all participants by individual receivers.

The Plant World announces the offering of two prizes for the best papers embodying original work in soil physics. The first prize will be $50 and the second $25, with the reservation of the right to withhold both prizes if no worthy papers are submitted or to combine the prizes for the rewarding of a paper of exceptional merit. The conditions governing the award will be similar to those employed in connection with the prizes for papers on the water relations of plants which were offered in April, 1915. The contesting contributions should be in the hands of the editor of *The Plant World* by December 1, 1916, and the announcement of the award will be made not later than March 1, 1917.

THE annual series of free public lectures under the auspices of the Harvard Medical School will be given, as usual, at four o'clock on Sunday afternoons at the Harvard Medical School. The lectures are:

January 2.—Dr. R. B. Greenough: "Cancer."

January 9.—Dr. W. H. Potter: "Military Dentistry; Experiences in a Three Months' Service in the American Ambulance Hospital, Paris."

January 16.—Dr. R. P. Strong: "Progress in Combating Epidemics of Some Infectious Diseases."

January 23.—Dr. R. B. Osgood: "Orthopædic Problems Presented by the European War."

January 30.—Dr. J. A. Honeij: "Leprosy."

February 6.—Dr. C. M. Smith: "Syphilis."

February 13.—Dr. F. H. Verhoff: "Some Simple Facts Regarding the Eyes that every one Should Know."

February 20.—W. H. Robey, Jr.: "The Value of Physical Examination to the Individual."

February 27.—Dr. C. J. White: "Occupation as a Contributing Factor to Certain Skin Diseases."

March 5.—Dr. W. R. Bloor: "The Rôle of Fat in the Nutrition of Man."

March 12.—Dr. F. S. Newell: "The Care of Pregnancy." (To women only.)

March 19.—J. L. Goodale: "Hay Fever and Asthma."

March 26.—Dr. F. W. White: "Chronic Indigestion."

April 2.—Dr. J. R. Torbet: "A Comparison of the Methods for the Relief of Pain in Childbirth." (To women only.)

April 9.—Dr. P. G. Stiles: "The Present Conception of an Adequate Diet."

April 16.—Dr. G. B. Magrath: "Death by Accident; Some of its Causes and How to Eliminate Them."

April 23.—Dr. H. P. Mosher: "The Management of Foreign Bodies in the Trachea, Bronchi and Esophagus."

April 30.—Dr. C. V. Chapin: "What the Individual Can Do to Protect Himself from Infection."

May 7.—Dr. R. I. Lee: "The Importance of Physical Examination in Health as Shown by the Examination of Harvard Students."

THE exploring excavations in the Mesa Verde National Park which the Department of the Interior is conducting under the direction of Dr. Jesse W. Fewkes, of the Smithsonian Institution, are successful to a degree scarcely anticipated when the work was begun, according to a statement by Mr. Enos Mills, sent out by the Department of the Interior. The new excavations are across the canyon from the Cliff Palace. This remarkable prehistoric village stands beneath the rim of the east side of the canyon while the structure now unearthed stands upon the rim of the west side. For many years visitors to the Mesa Verde National Park have noticed a huge mound opposite the Cliff Palace with trees growing upon it. It is this mound which the Department of the Interior determined to explore and under which Dr. Fewkes has found the most remarkable prehistoric structure north of the Aztec architecture in Mexico. It is of cut and polished stone. The building has the form of a capital D. The straight elevation is 123 feet long and the curved part 245 feet. The outer walls are double and between them are a series of narrow rooms. As the outer walls are unbroken, the entrance to this building must have been either subterranean or by the means of ladders through the top. Dr. Fewkes believes the ruin was an uncompleted fortress abandoned when the cliff dwellers disappeared from the Rocky Mountain region. At Moki Spring, a short distance from these ruins, there are a number

of other tree-grown mounds very similar in appearance to the one just excavated. Dr. Fewkes hopes next year to find what is concealed beneath.

UNIVERSITY AND EDUCATIONAL NEWS

THE contest over the will of the late General Brayton Ives, who left the bulk of his estate, valued at more than $1,000,000, to Yale University, has been settled by the filing of an order in surrogate's court. The contest was begun by General Ives's three daughters. The terms of the settlement were not divulged.

THE Duhring Memorial Building was formally dedicated on December 13 by the trustees of the University of Pennsylvania, and a memorial tablet was unveiled at the entrance to the new book stack. This new building is a wing to the library, and was erected as a memorial to the late Louis A. Duhring, professor of dermatology at the University of Pennsylvania, who left a legacy amounting to more than a million dollars to the university. The dedicatory addresses were made by Professor Morris Jastrow, Jr., the university librarian, and Dr. Joseph G. Rosengarten, chairman of the library committee of the board of trustees. The building was accepted on behalf of the university by Provost Edgar F. Smith.

A NEW building known as the Vivarium will soon be completed at the University of Illinois. It has been constructed especially for the work of Dr. Charles Zeleny and Dr. V. E. Shelford, of the department of zoology. The building, with furnishings, will cost about $70,000. Sea-water aquariums, a refrigerator system, and rooms in which light rays may be used to the exclusion of all others, are some of the things which make up the equipment of the Vivarium.

ASSOCIATE PROFESSOR H. P. BARSS has been promoted to be professor of botany and plant pathology at the Oregon Agricultural College, in place of Professor H. S. Jackson, who recently resigned to accept the position of plant pathologist at Purdue University.

DR. ALBION WALTER HEWLETT, professor of medicine at the University of Michigan, has accepted a similar appointment, beginning on August 1, 1916, in the Medical School of Stanford University. This fills the vacancy left by the appointment of Dr. Ray Lyman Wilbur as president of the university.

ASSISTANT PROFESSOR A. L. LOVETT has been made acting head of the department of entomology at the Oregon Agricultural College, in place of Professor H. F. Wilson, who resigned to accept a position as professor of entomology at the University of Wisconsin.

COUNT HUTTEN-CZAPSKI, of Posen, has been appointed curator of the Warsaw University and Technical School, as reestablished under German auspices.

DISCUSSION AND CORRESPONDENCE

THE TEACHING OF ELEMENTARY DYNAMICS

TO THE EDITOR OF SCIENCE: Since I took a hand, in SCIENCE of March 29, 1915, in the controversy between Professors Huntington and Hopkins concerning the fundamental equation of dynamics, there have appeared numerous communications on the subject showing evidence of widespread interest in it. As a result of these communications, the questions at issue are now in a more chaotic state than they ever were. The time now seems opportune for a review of the positions held by the several contributors, in the hope that they may yet be brought into agreement. I offer here some brief extracts from letters that have appeared in SCIENCE in the last six months, with my comments upon them, together with a condensed restatement of the problem I gave, with my solution of it, in my previous article, again asking that if any one thinks he has a better solution he will present it for comparison.

Uniformly Accelerated Motion

Problem.—A constant force, F pounds, acts for T seconds on W pounds of matter, at rest at the beginning of the time but free to move. What are the results? Explain how the results are derived.

Answer.—Experiments with the Atwood machine and other apparatus show (*a*) that the velocity varies directly as the force and as the time, and inversely as the quantity of matter;

(*b*) that the distance or space traversed varies as the force, as the square of the time, and inversely as the quantity of matter. It equals half the product of the velocity and the time. Expressed in algebraic form:

Velocity, feet per second,

$$V = \frac{FTg}{W}. \tag{1}$$

Distance, feet,

$$S = \frac{1}{2}\frac{FT^2g}{W}, \tag{2}$$

$$S = \frac{VT}{2}. \tag{3}$$

The value of g in these equations is always 32.1740 when W is the quantity of matter in pounds, as determined by weighing it on an even balance scale, F is in standard pounds of force (1 pound of force being the force with which a pound of matter is attracted to the earth at the standard locality, a place where the "acceleration due to gravity" is 32.1740 feet per second per second), and V is measured in feet per second. (In the metric system, if F and W are in grammes and V in centimeters per second, $g = 980.665$.)

Transposing (1),

$$FT = \frac{WV}{g};$$

or if

$$M = \frac{W}{g}, \quad FT = MV. \tag{4}$$

From (3),

Impulse = Momentum.

$$T = 2S/V;$$

substituting this value of T in (4)

$$2\ FS/V = MV;$$

whence

$$FS = \tfrac{1}{2}\ MV^2. \tag{5}$$

In (4) let

Work done = Kinetic energy.

$$V/T = A,$$

acceleration, then

$$A = M/F.$$

Whence

$$F = MA.$$

Force = M times acceleration.

Falling Bodies.—At or near 45 deg. latitude at the sea level $F = W$, then from (1) we have $V = gT$. If $T = 1$ second $V = 32.1740$ feet per second. At other locations, $F = W \times (g_1/g)$, or $Wg/32.1740$, where g_1 is the acceleration due to gravity at the given location. In equation (1) $V = FTg/W$, taking $F = W$, substituting for T its value $2S/V$, and for S the letter H, for height of fall, we obtain

$$V^2 = 2\ gH; \quad V = \sqrt{2\ gH}. \tag{7}$$

The expression Wg_1/g may be called the "local weight." It equals the gravitational attraction, measured in standard pounds of force, upon W pounds of matter. It is the weight that is indicated on a spring balance calibrated for the standard locality, so that it will measure standard pounds of matter at 45° at the sea level and standard pounds of force at any locality whatever.

Professor Hoskins, April 23:

> . . . introduce at the outset the body-constant which was called by Newton *mass* or *quantity of matter* . . . the acceleration of a body depends quantitatively upon both the applied force and the mass of the body . . . and the still more concise form $A = F/m$ results if units are so chosen that *unit force acting upon unit mass causes unit acceleration.*

There is no objection to these statements if it is clearly understood what is meant by the terms unit force and unit mass, but Professor Hoskins might have gone further and shown that this form of equation results if F is in dynes and m in grams or if F is in poundals and m in pounds, or if F is in pounds and m in slugs, but that is *not true* if F and m are both in pounds. It is true, however, if it is understood that F is standard pounds of force and that m is merely a symbol for the ratio W pounds of matter divided by 32.1740.

> Standard weight defined as the force required to give the body the acceleration 32.1740 ft. per sec. It is important to make clear the fact that the quantity called standard weight is in reality the measure of a body constant and is quite independent of gravity in spite of the fact that it is given a name which is almost always associated with gravity.

Professor Hoskins and I are here in exact agreement, but I am not sure that he is aware

of it. I hold that the standard weight of a body is the number of pounds of force required to give the body the acceleration 32.1740 ft. per second, whether that is the earth's gravitational attraction on the body at the standard locality or whether it is the force required to slide it along a frictionless plane with the same acceleration. It is also the measure of a "body-constant," viz., the constant quantity of matter in the body, as determined by weighing it on an even balance scale, which is quite independent of the value of the force of gravitation at the place where the weighing is done. The quantity of matter might also be determined by multiplying its volume by its specific gravity, or, if its specific heat were known, by finding how many degrees it would heat a given volume of water. For example, a piece of iron in cooling 100 deg. F. heats a cubic foot of water 1 deg., what is its weight, the specific heat of the iron being 0.111, and 62.36 British thermal units being required to heat a cubic foot of water one degree? Answer, $62.36 \div (100 \times 0.111) = 5.62$ lbs.

In other words, weight, or standard weight, is both a quantity of matter and a force. While matter and force are two entirely different things, force being a push or a pull and matter something that may be pushed or pulled, the quantity of matter in a body may be determined by finding how much force is required to lift it. Both the quantity of the matter and the amount of force are called the weight of the body. They are different things, but numerically they are the same. The weight of a 1 lb. weight (piece of metal) is one pound, that is there is a pound of matter in it, and the force required to lift it is also called its weight and is a pound, of force (not a pound-weight, with or without the hyphen, for that is a term that is properly applied to a piece of metal used for weighing other bodies).

This double definition of the word weight is sanctioned by a thousand years of usage. It is universal in literature and in commerce. In the vain attempt to get rid of it the text-book writers have substituted the word "mass" for weight, meaning quantity of matter, and tried to confine the word weight to mean the amount of gravitational force acting on a body; but the great public will not have it so; they will continue to call both the force and the quantity of matter by the good old word weight. Then the text-book writers thought it would be a good thing to hybridize the C.G.S. system with the English system of weights and measures, and say unit force is that force which gives unit mass unit acceleration, and they invented the poundal to achieve this result; then, that device leading to trouble and confusion, they invented the gee-pound or slug and so increased the trouble.

> In fact it (a supported body) has an acceleration even though at rest relatively to the earth.

I do not understand Professor Hoskins here. If acceleration means change of velocity divided by time, and rest connotes no change of velocity and no velocity, how can a body at rest on the earth's surface have an acceleration relatively to the earth, that is radially toward the earth's center, or relatively to a fixed point in space, if there is no change in the speed of rotation of the earth?

Professor Hoskins, May 7:

> Mr. Kent's equation $V = KFT/W$ is entirely satisfactory and sufficient so long as our study is confined to the cause in which a force whose direction and magnitude remain constant acts upon a body otherwise free and initially at rest. This is, however, a very exceptional case. The fundamental *principle in its generality* can be expressed only by introducing the notion of instantaneous rate change of velocity, *i. e.*, acceleration.

I am glad that Professor Hoskins admits the sufficiency of the equation for the particular case to which I applied it, that of the body initially at rest acted on by a force constant in magnitude and direction. I call this equation fundamental because it is derived from experiment with the Atwood machine or other apparatus, and because it is a foundation upon which other equations may be built. Now let us build on it to arrive at the general case, by removing the restrictions of the original problem. Take unit force as the force which acting for one second gives a pound of matter a velocity of 32.1740 feet per second, then the

equation becomes $V = 32.1740\ FT/W$. Remove the restriction that the body starts from rest, and let it have at a given instant a velocity V_1 and at the end of the time T a velocity V_2. Let $V = V_2 - V_1$, then the equation applies equally well to this case, if we define V as the *increase* of velocity during T seconds.

Now remove the restrictions that the body is not retarded by friction and that the force is constant. The velocity then will not vary directly as the time, but in some other way, which can be expressed graphically by plotting velocities or distances against time. The problem is now not one of uniformly accelerated motion and it belongs to another chapter of the discussion, but we can still use the same formula if we differentiate it, assuming that for a differential of the time the force and the quantity of matter are constant. We then have $dv = 32.1740\ F/W\ dt$ or $dv/dt = 32.1740\ F/W$. This is a formula for the general case, but it is not fundamental; it is derived from the fundamental equation $V = FTg/W$ after dividing both sides of the equation by T. The notion of instantaneous rate of change of velocity, *i. e.*, acceleration, is not introduced until we give the name acceleration to the quantity dv/dt (or V/T if the acceleration is constant), and the term mass does not appear until we give the name mass to the quotient W/g and thus derive $A = F/M$, or $F = MA$, a most useful equation when we define M as W/g, but it is derived and not fundamental.

Professor Fulcher, April 30:

Gravitational force overcome—weight raised.
Elastic force overcome—spring stretched.
Frictional force overcome—sled dragged.
A pound weight (lb. wt.) is the force required to lift 3.55 cu. in. of iron.

I approve of Professor Fulcher's method of progressing from matters of every-day experience, and it is the method I use, as shown in my article in SCIENCE, December 24, 1909. I am glad to see that he uses the words "weight raised" instead of "mass raised," for the words are in harmony with the young student's understanding of the word weight. I should prefer, however, to say elastic resistance and frictional resistance, instead of elastic force and frictional force. The use of "pound weight (lb. wt.)" instead of the term "pound force" I consider objectionable. The word weight is now used correctly and generally in common language with two meanings, (1) quantity of matter (determined by weighing it on an even balance or by multiplying its volume by its specific gravity), and (2) the force with which the earth's gravity attracts that matter; while the words "pound weight" have a specific meaning, viz., a piece of metal marked 1 lb., used in weighing. Neither "weight" nor "pound weight" are properly applied to the horizontal force required to drag a sled or to a vertical force of 1 lb., as measured on a spring balance, exerted (vainly) to lift a 2 lb. weight.

Before we can determine the effect of a constant unbalanced force in changing the motion of a body, we must study some simple types of motion: (1) uniform; (2) constantly changing speed; (3) parabolic motion; (4) uniform circular motion; (5) motion due to a constant gravitational force.

I would teach (1) very briefly and postpone (2), (3) and (4) until after (5) had been studied experimentally with Atwood's machine, and until after the problem of a heavy boat in still water, pulled with a very small force, say 1 lb. on a 1,000-lb. boat for 4 seconds (frictional resistance neglected) had been studied, deriving the general equation of constant acceleration (2) from the experimental data.

Gravitational Units.—I would drop this term and substitute two others, (1) English units: pound, foot, second, (2) metric units, kilogram (or gram) meter (or centimeter), second. These units are absolute if W is defined as quantity of matter obtained by weighing on an even balance scale and g is 32.1740 ft. per sec. = 980.665 cm. per sec.

Absolute Units.—I would drop this term, also the poundal, and substitute C.G.S. (centimeter-gram-second).

Alexander McAdie, April 30:

Now what is the difficulty with the C.G.S. system?

The difficulty pedagogically is the definition of the dyne, the force that gives a gram of matter an acceleration of 1 centimeter per second per second, and the fact that it has to be translated into its equivalent in ordinary language, a force of 1/980.665 gram, before a clear concept of it can be obtained. If it had been defined as the force which gravity exerts on a gram of matter at 45 deg. latitude at the sea-level, it would have been better. Practically the difficulty is that C.G.S. units derived from the dyne are generally so small that they usually have to be multiplied by a million or more to make them usable, or to express them in such terms as "the joule is 10^7 ergs," and "the ohm is equal to 1,000,000,000 or 10^9 units of resistance of the C.G.S. system."

> It is not so difficult for one to break away from the old units as may be imagined. A year's constant use of the C.G.S. units makes one feel like saying when reading of inch measurements "Inch, inch? Where have we met that term before?"

Of course it is not difficult for *one* who is engaged constantly in the use of the C.G.S. system, and who during that year has had no occasion to use the old units, to break away from them, but it is not only difficult but impossible, for a hundred million people who are constantly using the old units to break away from them.

T. L. Porter and R. C. Gowdy, June 4:

> We think Professor Kent has done well to retain force and quantity of matter as equally fundamental.

Thanks! I am glad of their company so far, but I can not follow them in adopting the "gravital" as a unit of acceleration. I invented that term myself years ago, as a distance of 32.2 feet, only for the purpose of using it as a "horrible example." I fear now that some one else will adopt my "timal," 1/32.2 of a second. Still less can I accept their micro-speedal or their six Greek letter constants. Perhaps my sense of humor is lacking, in failing to recognize that their article is a joke and a satire, but it reads as if they seriously mean all they say. Here are some brief quotations from their article.

> Let $W =$ matter in pounds.
> $F =$ force in pounds.
> Mass shall be an exact equivalent for quantity of matter.
> Weight means the gravitational *force* upon a mass.
> The measure of a force may be defined by the equation $F = ma$.
> There are 32.2 of the units of force defined by $F = ma$ in a pound weight.
> What is the *unit* of m if not the slug?
> We frankly talk about a unit of force called the poundal.

If I understand this rightly Messrs. Porter and Gowdy measure matter in both pounds and in slugs, and force in both pounds and in poundals, and to my mind this only increases the existing confusion.

I have just looked over the solution of my problem and I find that it contains twelve technical terms, including one constant, viz., force, pounds, matter, seconds, velocity, distance, acceleration, impulse, momentum, energy, work; $g = 32.1740$.

Messrs. Porter and Gowdy's article contains the same twelve, and also fourteen additional ones, viz., micro-speedals, gravitals, mass, weight, poundals, slugs, pounds-weight, unit and six Greek letter constants. The object of my work has been to eliminate as many useless terms as possible, with the view of making the subject of dynamics easier. Their object seems to be to use as many terms as possible. I wish they would give my problem to a class of their students, and ask them to take it home and bring in written solutions in the method in which they have been taught. The problem for this purpose might have added to it one to be solved arithmetically, such as a 1,000-lb. boat is pulled with a force of 1 lb. for 4 seconds. Assuming that frictional resistance may be neglected, find the distance, velocity, acceleration, etc.

Paul F. Gaehr, June 25:

> I say that we may take as our unit of force that force which gives to unit mass a unit acceleration. Let us fetch that backward baby, the poundal, into the room for an inspection at least long enough to learn that the weight of a pound is 32 poundals.

Yes, we may inspect that backward baby a

while, but the students will forget it, just as the students do who are told that we may take as our unit of mass that mass to which unit force (1 pound) gives unit acceleration, and are asked to inspect that more modern baby the slug, alias gee-pound, which will also be forgotten.

Why not teach that the unit of force is that force (1 pound) which gives to unit quantity (1 pound) of matter (call it weight or mass as you will) an acceleration of 32.1740 feet per second, or the force with which a pound of matter is attracted to the earth at a standard locality? That baby was pretty old before the poundal and the slug were born, and now as a strong man is about to attend their funeral.

Professor Huntington, July 30:

(P. 158) Professor Hoskins's method presupposes as a matter of common knowledge the difficult concept of mass or inertia, while my method postpones the introduction of this concept until the student is in a position to define it in terms of the simple concepts of force and acceleration.

(P. 159) Mass as a factor in the determination of motion means the constant ratio of force to acceleration, and whatever the words quantity of matter convey to a beginner's mind they certainly can not convey this desired idea of mass and inertia until *after* the ideas of force and acceleration and the idea of constancy of their ratio for a given body has been accepted.

If $FT = MV$, then $FT/V = F/A$; $F = MV/T = MA$; $T = MV/F =$ Momentum/Force; $V = FT/M =$ Impulse/Mass. Mass no more means the ratio of force to acceleration than force means the time-rate of the increase of momentum, or that time means the ratio of momentum to force, or that velocity means the ratio of impulse to mass. These equations are merely algebraic statements of numerical equality. Not one of them is a definition. Moreover, they are not true, if mass and force are both measured in pounds or in kilograms. They are true in the C.G.S. system, in which force is measured in dynes and mass in grams, and also in the hybrid systems in which force is in poundals and mass in pounds, or force in pounds and mass in slugs. They are also true if it is understood that M is just a symbol for $W \div 32.1740$, W being weight, the word weight being defined as both the force which gravity exerts on a body where $g = 32.1740$ and the quantity of matter in pounds as determined by weighing it on an even balance scale.

There is no difficulty whatever in the beginner's mind in the "concept" of weight with this double definition; his difficulty begins when he is told by the text-books and the teachers that weight is a variable quantity changing with locality, and that mass according to some writers means quantity of matter in slugs, by others it means ratio of force to acceleration, by others that it means the constant ratio of a variable weight (force of gravity) on a body to a variable value of g, and by still others that it is the same thing as inertia.

(P. 164) The awkward attempt to make mass the fundamental unit and force the derived unit has been practically abandoned in the accepted terminology of pure science. Why should it not be abandoned in elementary teaching?

Certainly it should be abandoned, and so also should be abandoned the equally awkward attempt to make mass a derived unit, the ratio of force to acceleration. As Professor Hoskins says in his footnote (page 610, April 23):

Professor Huntington's statement that the mass concept is a "derived concept both historically and practically" is hardly true in any sense in which it is not also true of force. At all events, mass in the sense of quantity of matter has been treated as fundamental by many high authorities from Newton down.

Everybody (writers of text-books on mechanics and some teachers not excepted until they get into "pure science" and become metaphysical) knows that neither force nor quantity of matter are derived concepts; both are elementary and fundamental concepts. As I said six years ago in my article on "The Teaching of Elementary Dynamics in the High School":[1]

Matter.—A stone is suspended by an elastic cord from a nail driven into a projecting shelf. The stone is a piece of matter. . . . Quantity of matter determined by weighing on an even balance scale. The weight of the stone is W pounds.

[1] SCIENCE, Dec. 24, 1909.

Force.—The cord is stretched when the stone is hung on it. Measure the stretch per foot of length. . . . But the cord may be stretched by pulling it between the two hands horizontally. . . . The pull of the earth upon the stone . . . the pull of the hands, . . . each is called by the name force, F.

Space. Time.—Let the cord be suddenly detached from the stone. The stone falls to the ground. It traverses a certain distance, S feet, in a certain time, T seconds.

Here are four elementary, fundamental and independent concepts. Neither one of them is derived from any function or ratio of the other three.

(P. 161) In regard to the equation $V = FTg/W$, which has been proposed by Mr. Kent, my feeling agrees with that expressed by Professor Hoskins, namely that no equation which covers only the special case of a body starting from rest . . . (can be considered as) a fundamental equation in mechanics. Mr. Kent's paper, however, is not without interest on the pedagogical side.

Not without interest! I have been told by those who have used my method that it is pedagogically admirable. The editor of SCIENCE has sent me a letter from an engineer in California enclosing 15 cents for a copy of SCIENCE containing my article, to be sent to his son in college, saying that in 25 years' experience it was the best presentation of the subject he had seen. I presented it on the blackboard at the Princeton meeting of the Society for the Promotion of Engineering Education, June, 1914, where I challenged the professors present that if they did not like my method they write out a better one. Thus far no one has accepted my challenge. The problem is not one of mechanics; it is one of a method of teaching; it is one of pedagogy and the English language, how to find a form of words to be put into a text-book to explain the fundamental principles of dynamics in a way that will appeal to the young student and get these principles into his head in the easiest way possible. After over a year of "watchful waiting" I have put a condensed summary of the method as given in my article in SCIENCE of March 19, 1915, into the chapter on Mechanics in the ninth edition of my "Mechanical Engineers' Pocket-book," which will be off the press about December 10. The young engineers who use the book will there find an antidote to what they have been taught in the past about poundals, slugs, gee-pounds, engineer's unit of mass, derived "concepts," "force is the time-rate of the increase of momentum," "mass is the ratio of force to acceleration," "the unit of mass is 32.2 pounds, the unit of force is 1/32.2 of a pound," and the like. I even have hopes that the Committee on Teaching of Mechanics, of the Society for the Promotion of Engineering Education, of which committee I am a disturbing member, disturbing the slumbers of the committee about once a year, will in two or three years more get over its negative acceleration or minus inertia and adopt my method in its final report.

Professor Hoskins, August 27:

That "the result of weighing a body on a balance scale" is a proper measure of "amount of material" certainly requires explanation to the beginner.

Not to a boy who understands the English language and has ever seen a grocer's scale used to weigh sugar.

I see no reason why the unit which has been called the slug should be regarded with ridicule or even semi-ridicule. The convenience of the slug is due to two facts (1) that the pound force is customarily employed in a great deal of practical work, and (2) that the dynamical formulas almost universally employed are based on a relation of units such that unit force acting on unit mass causes unit acceleration.

The dynamical formulas universally used by engineers are based on no such relation. They are (1) $FT = MV$, (2) $FS = \frac{1}{2}MV^2$, (3) $V = (FT/W) \times g$, and in each case where M is used it means simply W/g.

In order to make the equation $FT = MV$, in anything but the C.G.S. system, harmonize with the statement that "unit force acting on unit mass causes unit acceleration," we must do violence to the English language and custom and use an artificial expedient not sanctioned in literature outside of the text-books, or in commerce, or in engineering practise.

Thus we may say

$$F \times T = M \times V;$$

poundals $\times$ seconds = pounds $\times$ feet per second; 1 poundal = 1/32.2 pound force;
pounds $\times$ seconds = slugs $\times$ feet per second; 1 slug = 32.2 pounds;
pounds $\times$ timals = pounds $\times$ feet per second; 1 timal = 1/32.2 second;
pounds $\times$ seconds = pounds $\times$ gravitals per second; 1 gravital = 32.2 feet.

The timal and gravital are just as ridiculous or semi-ridiculous as the poundal or slug, and no more so. Neither one of them has any reason for existence except the pleasing alliteration, copied from the C.G.S. system, "unit force acting on unit mass causes unit acceleration." I see no reason why we should use this principle when it leads to no useful result, but does lead to the worse than useless ones of wasting the time of the student and confusing his mind. If it is such a good thing, why has it not yet been grafted on the metric system? Why do we not have kilogrammal as a unit of force and kiloslug as a unit of quantity of matter?

Is there any reason why in the English system we should not adhere to the good old principle, Unit force (pound) acting on unit mass (1 pound) gives it an acceleration of 32.1740 feet per second?

Professors Franklin and MacNutt, September 24:

> Let us retain as the fundamental meaning of the word mass the result of weighing on a balance scale. . . . Use a balance on a batch of sugar and you get always and everywhere the same numerical result. . . . We respect the experience of two thousand years in that we base our definition of mass on the use of the balance.

I have no objection to the physicists' using the word mass in this sense, but they should not try to prevent their students from using the word weight in the same sense; and I do object to their telling their students that the unit of force is a poundal, when all the rest of the world says it is a pound.

Professor Wilson, October 15:

> To obtain valuable training in kinetics a knowledge of the differential and integral calculus, including the simpler differential equations, is necessary . . . . We therefore have the fundamental equation of kinetics in the form $d/dt\ (mv) = gf$.

The calculus is not at all necessary when we are dealing with uniformly accelerated motion, and valuable training in kinetics was obtained in the study of the early editions of Weisbach, in which calculus was not used. In fact when the problem involves acceleration not constant, but varying according to some assumed law a graphical or arithmetical solution of it will be more useful training than its solution by the calculus. Let Professor Wilson give to his students the boat problem with frictional resistance added and find what results they get by applying his differential formula to it. The problem is: A boat with its load, the total weighing 1,000 pounds, is towed in still water with a constant force of 1 pound. The frictional resistance is $0.2v^2$ pounds, v being speed in ft. per sec., and the force available for acceleration is $(1 - v^2)$ pounds. What speed will the boat have at the end of 1, 2, 3 and 4 minutes; how far will it travel each minute and how long time will it take to bring it to a speed of 0.999 of the theoretical maximum at which the acceleration is zero?

> It is of course true that weight is not a definite constant thing from place to place.

It is a constant thing if weight is defined, as is customary in commerce, as the quantity of matter in pounds determined by weighing it on an even balance.

> . . . proceed to Newton's law that the rate of change of momentum is equal to the force. Here however we have an equation that is no longer homogeneous either in the mass or in the force.

This is a new kind of language to me. I confess my ignorance of the meaning of the phrase "homogeneous either in the mass or in the force." Whatever it may mean it surely has no place on "elementary" mechanics.

> The equation $ma = f$, or any equation involving accelerations leads to the ridiculously needless concepts of transverse and longitudinal (and an infinity of oblique) masses.

Here again Professor Wilson is too deep for me. I have used the equation $ma = f$ for forty years (understanding that m means the quotient w/g) and never have been led to any such concepts. I thank Professor Wilson for the expression "ridiculously needless con-

cepts." It fits exactly the poundals, slugs, gee-pounds, engineers' unit of mass, gravitals, micro-speedals, kinetic unit, scientific unit, absolute and gravitational systems, "concepts of mass," "force is the space rate at which work in foot pounds is done, it is also the time rate at which momentum is produced or destroyed" (Perry's "Calculus") and all such pedagogical rubbish.

> Our first object is to get the student into a position where he can solve such simple problems as he sees in actual work about him, and a certain amount of ignorance which would be very lamentable on the part of myself and your other contributors, is highly praiseworthy in the student.

Good! Now will Professor Wilson examine the simple problem I have given and my method of solving it and get one of his instructors to experiment on the method with some freshmen students and report the result? "Try it on the dog." Test it not only by the canons of logic and of common sense, but also by experience.

> Any student knows what a weight of four pounds is.

Of course he does, until he begins the study of physics; then he may be in some doubt about it. He knows that it is a piece of metal with "4 lb." stamped on it, but when he is told that that is not a weight, but mass, and that a weight of four pounds means a force of four pounds, also that a mass is "the constant ratio of force to acceleration," and that "he can not acquire the desired ideas of mass and inertia until after the ideas of force and acceleration have been accepted," it is no wonder that he becomes confused, and replies to the simple question, "What is force?" "The time-rate of the change of momentum," quoting from the text-book, without knowing what the words mean.

Wm. Kent

A MNEMONIC COUPLET FOR GEOLOGIC PERIODS

Several years of experience in teaching geology led me, some time since, to the invention or discovery of the following scheme for helping students to remember the order of geologic periods.

The form offered here is adapted to the plan presented in Chamberlin and Salisbury's "College Geology," which is widely used. It may be modified without serious difficulty to suit other time divisions.

Neglecting the Pre-Cambrian, somewhat as common histories do pre-historic time, and also the recent epoch, we take the periods of the Paleozoic era, Cambrian, Ordovician, Silurian, Devonian, Mississippian, Pennsylvanian and Permian; of the Mesozoic, Triassic, Jurassic, Comanche and Cretaceous; and of the Cenozoic, Eocene (Oligocene), Miocene, Pliocene and Pleistocene.

Taking the first syllable of each period, and adding the termination *ice* to the Permian to commemorate the glacial epoch of that time, and also to rhyme with "Pleis," which also reminds one of the better known epoch of the same sort, we have the following jingle:

Cam.Or.Sil.De.
  Miss.Penn.Perm-*ice*,
Tri.Ju.Co.Cre.
  E.(Ol.).Mi.Pli.Pleis.

Some of the divisions here counted periods may be more fittingly called epochs, but that makes no difference with the order.

J. E. Todd

University of Kansas

VARIATION IN ŒNOTHERA HEWETTI

Dr. G. H. Shull[1] recently published a paper on "A Peculiar Negative Correlation in *Œnothera* Hybrids," in which he showed that in certain cultures dull dark red stems were associated with entirely green buds, and gave other evidence indicating that the appearance of anthocyan in one part of the plant by no means involved its appearance in other parts.

I have this year a series of plants of *Œnothera hewetti*, descended from the original plant brought from the Rito de los Frijoles, New Mexico, in 1912. This is a relative of *Œ. hookeri*, and quite distinct from the species used by Dr. Shull. Nevertheless, it varies in pigmentation along practically the same lines.

[1] *Journal of Genetics*, IV., 1914, p. 83.

Thirteen plants examined fall into three groups, as follows:

(a) Stems and midribs of leaves dark crimson; buds entirely green. Three.

(b) Light green stems, slightly speckled or washed with reddish; midribs light green; calyces broadly striped with red, as de Vries[2] figures for *Œ. hookeri*. Six.

(c) Red stems and mid-ribs, and red-striped buds. Four.

Thus there is rather absence of correlation than negative correlation, except that no green-stemmed plants with green buds were found.

Mr. H. H. Bartlett, who grew *Œ. hewetti* from my seed in 1914, found the plants diverse, and mostly self-sterile, which led him to suggest (in litt.) that the form might be of hybrid origin. My plants seem quite uniform except in color, as described above, and in the size of the flowers, which seems to vary largely according to the condition of the plant, or on the same plant according to position.[3] No other *Œnothera* was observed in the original locality of *hewetti*, and the only species growing in the vicinity at Boulder (until last summer, when I had a single small plant of *Œ. rubricalyx*) is *Œ. cockerelli* Bartl., one of the small-flowered group. It seems probable that *Œ. hewetti* is a pure species, which varies or mutates in the same manner as other members of the genus.

I have this year a very fine plant of *Œ. rubricalyx*, which is even redder than Gates's original figure,[4] having the buds, including the hypanthium, entirely dark red, excepting the green sepal tips. The stems are dark red, more or less streaked with green, but the midribs are green, only faintly speckled with red. Thus this intensely pigmented plant has the midribs much less pigmented than in the red-stemmed form of *hewetti*, although the buds are very much more intensely pigmented than in the latter.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO,

July 18, 1915

[2] "Gruppenweise Artbildung," pl. VIII.

[3] This refers to the grown plants. Some diversity in the rosette leaves was noted.

[4] *Zeits. f. indukt. Abstammungs-u. Vererbungslehre*, Bd. 4, pl. 6, f. 8.

QUOTATIONS

THE CONVOCATION-WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE scientific men of the country will hold their annual meetings this year at widely separated places and with some conflict. The American Association for the Advancement of Science is responsible for the arrangement of the convocation-week meetings, having fourteen years ago transferred its own meeting from mid-summer to the Christmas holidays. At the same time it obtained from many universities and colleges an extension of the Christmas holidays or grants for leave of absence, so that the week in which New Year's day falls should be free for these meetings. The American Association arranges also for the meetings of affiliated scientific societies which may wish to meet in conjunction with it. It is not expected that all these societies will meet every year with the association, for there are obvious advantages in the isolation of a single society or a small group concerned with related subjects, as well as in a large congress covering all the sciences and numbering its attendance by the thousands.

In order to meet the complicated conditions as well as may be, the American Association has planned a program, according to which once in four years there shall be a great convocation-week meeting representing all the natural and exact sciences, and perhaps, ultimately, also engineering, education, economics, history, philology, literature and art. Such a demonstration of the intellectual forces of the country should be a stimulus to those who join in it and an exhibition that would impress the whole country. It is proposed to hold these meetings once in four years and in succession in New York, Chicago and Washington. The first will take place in New York at the end of the year 1916, and thereafter they will he held in the four-year periods at which the national presidential elections occur. In the intervening two-year periods the meetings will also be in large scientific centers, and it is expected that most of the national scientific societies will take part. The first of these meetings was held in Philadelphia, and the next will probably be held in Boston at the

end of the year 1918. In the intervening years the American Association will meet at places more remote from the large centers of scientific population, or in cities or at universities where the accommodations are more limited. The first of these meetings was in Atlanta at the end of the year 1913, and the meeting this year is at the Ohio State University, Columbus. In 1917, it will probably be in Toronto, Nashville or Pittsburgh.

At these meetings the attendance of scientific men is in the neighborhood of a thousand; at the larger meetings it may be two or three thousand, and at the four-year periods, from five to ten thousand. The vast extent of the country makes it difficult for the scientific men of the west to visit the east, and conversely, during the Christmas holidays, and summer meetings may be held in the west once in four years, the first having been held this summer in connection with the Panama-Pacific Exhibition, and on the occasion of the organization of a Pacific Division of the Association.

Although the meeting of the American Association opening at Columbus, on December 27, is not one of the larger convocation-week meetings, it promises to be of more than usual interest to those who are able to be present, as was the case with the meeting held at the Ohio State University some fifteen years ago. The address of the retiring president, Dr. Charles W. Eliot, who, called from a chair of chemistry to the presidency of Harvard University, has become by common consent our leader in education, is on "The Fruits, Prospects and Lessons of Recent Biological Science." An introductory address will be made by the incoming president, Dr. W. W. Campbell, the distinguished director of the Lick Observatory. Among the vice-presidential addresses before the eleven sections of the association may be noted important subjects, treated by Professor White, of Vassar College, in mathematics; Professor Zeleny, of Yale University, in physics; Professor Lillie, of the University of Chicago, in zoology; Professor Pearce, of the University of Pennsylvania, in pathology; Professor Hanus, of Harvard University, in education, and Dr. Bailey, formerly director of the Cornell Agricultural College, in agriculture.

Eighteen national societies, including the American Society of Naturalists, and the societies devoted to mathematics, physics, zoology, entomology and botany meet at Columbus in affiliation with the American Association. The chemists do not hold a winter meeting this year. The psychologists and pharmacologists meet in Boston; the anatomists in New Haven; the psychologists in Chicago; the philosophers in Philadelphia; the geologists, paleontologists, geographers, anthropologists, sociologists and economists in Washington.

The serious conflict of the year is with the Second Pan-American Scientific Congress meeting in Washington from December 27 to January 8. It was originally planned that this congress should meet in the autumn, but the date was changed and the preliminary arrangements were made without consultation with American scientific men. The officers of the congress, selected presumably by the department of state, are Mr. Phillips, the third assistant secretary of state, chairman of the executive committee; Mr. Scott, secretary of the Carnegie Endowment for International Peace, vice-chairman; Mr. John Barrett, secretary-general; and Mr. Glen L. Swiggett, assistant secretary-general. The department of state is probably as ignorant of the scientific conditions of the country as the navy department, whose secretary when asked why he had ignored the National Academy, by law the scientific adviser of the government, and the American Association, the great democratic body of scientific men, in selecting the societies to elect members of the Naval Advisory Board, appeared never to have heard of either association. A program in nine sections has been arranged for a "scientific" congress, which ignores mathematics, physics, pure chemistry, geology, zoology, botany and psychology.

However, attempts have been made to rectify the earlier errors. Dr. Welch, president of the National Academy of Sciences, has been made honorary vice-chairman, and Surgeon-General

Gorgas, Dr. Holmes and Dr. Woodward have been added to the executive committee. The conflict in time does not extend to the second week of the Pan-American Congress, and it is probable that after the adjournment of the Columbus meeting a special meeting of the American Association will be held at Washington. Under existing conditions, it is extremely desirable that friendly relations and cooperation in science should be maintained among the American republics.—*The Scientific Monthly.*

SCIENTIFIC BOOKS

Elemente der exakten Erblichkeit mit Grundzügen der biologischen Variationsstatistik. By W. JOHANNSEN. Zweite deutsche, neue bearbeitet und sehr erweiterte Ausgabe. Jena, G. Fischer. 1913. 724 pp.; 35 figs. in text.

The second edition of Johannsen's epoch-making work which follows the first by only four years has added nearly 200 pages, or 40 per cent., to the first edition. The number of lectures has been increased from 25 to 30, by the division of one to which much material has been added, by wholly new lectures (Nos. 12, 13) and by five final lectures instead of three.

The significance of Johannsen's book can now, after the lapse of years, be better evaluated than before. It had long been a truism in biology that the hereditary substance—the stirp or germ—must be carefully distinguished from the person or soma, and Galton was one of the earliest to make this distinction. It was, therefore, a great step backward when Galton announced his law of ancestral heredity according to which an individual inherits from his two parents together 50 per cent. of his whole heritage; from his four grandparents 25 per cent., and so on. It only testifies to the depth of the darkness in which we were groping that any of us should have seized upon *that* as a solution of the mystery of heredity.

The rediscovery of Mendel's law wiped away that fog and brought us again to germ cells. Still we did not fully sense the bearings of that law. We still clung fondly to the idea that the soma was so important an index to the hidden germ plasm that we could make progress by somatic *selection.* And it required the first edition of Johannsen's "Elemente" to set us straight there. Ever since we have recognized that even if one can make progress by somatic selection it is more or less by accident and by rule-of-thumb. For what we are selecting is truly the germ plasm, even though we think we are selecting somas; and we are successful only in those cases in which there happens to be a considerable correlation between the two. Ever since Johannsen's book appeared somatic selection merely—as such—has been realized to be futile for evolution, although somatic selection as a means of eliminating or preserving certain kinds of germ plasm may be, and in some cases is, of great theoretical and practical importance.

In the new edition, new, original experimental material on pure lines in beans is afforded with results quite the same as before. More space is given to a critical examination of the later studies on selection such as the favorable ones of Jennings, East, Pearl, Tower and Gates and the unfavorable ones of Castle, Lutz and Harris among American investigators. The unfavorable investigators Johannsen finds to fall into two groups; those whose experiments have yielded results opposed to Johannsen's and those who, without contradicting his results, have opposed their general validity. The opposing experiments rest either on the fact that the original material was not homogeneous or result from a "secondary selection" such as the selection of the best nourished individuals whose young start life in each generation on a higher nutrition-plane even though no genotypic change has occurred. There seems to the reviewer a certain weakness in the author's explanation of the discordant results of some workers (*e. g.,* Lutz). It would seem more probable that some of the favorable results of selection are due to unexpectedly abundant mutation. The last 90 pages of the book contain the most new material. Here are recorded, with evidence of great research into the literature, the results of the newer experiments in hered-

ity; the various deviations from simple Mendelian proportions, hypostasis and latency, sterility and inbreeding. The author also treats of coupling and "repulsion" without being able to make use of the flood of light that Morgan and his pupils have thrown upon these ideas. Indeed, Johannsen at the time of writing the book was not inclined to ascribe to the chromosomes the importance in heredity that is commonly conceded to them in this country.

In his final chapter Johannsen considers certain relations of the results of heredity to man and to evolution. He thinks the fact that culture (euthenics) has no effect on the race makes it not less but the more significant; for the momentary position of the race is the summation of personal qualities. In a sense it is true that the worse the breeding the greater the need for cultivation if any sort of a crop is to be harvested. As for the bearing of the new facts of heredity on evolution Johannsen has little to say and he states that we miss to-day the genius of a Darwin to establish a theory of evolution in harmony with modern knowledge.

C. B. DAVENPORT

Einführung in die Tierpsychologie. Erster Band, Die Sinne der Wirbellosen. VON GUSTAV KAFKA. J. A. Barth, Leipzig. Pp. xii + 593. 8vo. 362 text illustrations.

Animal psychology, according to Kafka, takes its departure from the same body of facts that sensory physiology does, but differs from this subject in the problems it sets itself for solution. That most of these problems are still unsolved justified the author in his opinion that a good text-book on animal psychology should concern itself with the facts of animal reactions rather than with theoretic matter. The book holds consistently to this view. It contains, after a very brief introduction, an account of the rapidly accumulating material on the sense of touch, the static sense, the sense of hearing, the temperature sense, the chemical sense, the light sense, and the very questionable senses of space and of time, all in invertebrates. The volume is well illustrated and is concluded by a bibliography of over five hundred titles in a well-ordered arrangement. As an introduction to the newly discovered facts in animal reactions the volume is in every way serviceable, though from the rate at which the subject is growing the book is bound soon to fall behind the times. As a means of quickening in the student a sense of the general problems in this field of research, it is disappointing. This fault may be excused on the grounds that it is just this side of the subject that the author has intentionally avoided, but it is an open question whether this avoidance is really a virtue. While the volume from its clearness and directness of statement will be found of much use to the student of animal psychology and allied subjects, its failure to deal with the more obvious general problems of this field of science must be regarded as a real defect. Possibly this may be remedied in the companion volume on the vertebrate senses which is said to be in preparation by the same author.

G. H. PARKER

SPECIAL ARTICLES

HEREDITY AND INTERNAL SECRETION IN THE SPONTANEOUS DEVELOPMENT OF CANCER IN MICE

AFTER preliminary studies in 1901 and 1902, and subsequent observations in 1907 suggesting the significance of heredity in the spontaneous development of cancer in rats and mice, we undertook an analysis of the hereditary factors on a larger scale in 1910 in conjunction with Miss A. E. C. Lathrop in Granby, Mass.[1]

[1] Loeb, L., *Medicine*, 1900, VI., 286; *Centralbl. f. Bakteriol.*, I., Abt., Orig., 1904, XXXVII., 235; *Univ. Penn. Med. Bull.*, 1907–08, XX., 2; *Centralblatt. f. allg. Pathol.*, 1911, XXII., 993. Lathrop, A. E. C., and Loeb, L., *Proc. Soc. Exp. Biol. and Med.*, 1913, XI., 34. Loeb, L., *Lancet-Clinic*, 1913, CX., 664. Lathrop, A. E. C., and Loeb, L., *Journal Exp. Med.*, XXII., Nov., 1915, 646, and Dec., 1915, 713. The credit for the first investigations on a somewhat larger scale into the possible influence of heredity on the tumor incidence in mice belongs to E. E. Tyzzer (*Jour. Med. Research*, 1907–08, XVII., 155). The procedure

Without going into a detailed discussion of the various conclusions arrived at, it may suffice to state as one of the principal results that different strains of mice kept in the same environment, being given the same kind of food, differ very much in the frequency with which cancer occurs among them. (Carcinoma of the mammary gland in females is by far the most common kind of cancer in mice.) In some of them cancer may affect as many as 70 per cent. of the female mice, while in other strains only 2–3 per cent. are affected. In succeeding generations this percentage figure is fairly constant in different strains of mice. Equally characteristic for different strains seems to be the age at which cancer occurs; while in some strains it occurs at a relatively early age, in others it appears later in life. Such differences in the cancer age may exist even in strains in which the cancer incidence is similar.

These data are a prerequisite for further studies of factors responsible for the spontaneous development of cancer as well as for attempts to diminish or increase the cancer incidence at will. From a practical point of view such studies may ultimately lead to the discovery of means enabling us to lower the cancer rate or to prevent cancer. As a first contribution to this problem we undertook, on the basis of our previous results concerning the significance of heredity, an analysis of the influence of the ovary and especially of the corpus luteum in the spontaneous development of cancer of the mammary gland in mice. We had shown previously that a combination of a mechanical stimulus and the influence of a substance secreted by the corpus luteum at a definite period of its existence led to the production of rapidly growing tumor-like new formations with the structure of the decidua in all parts of the uterus. After a period of at first rapid and then declining growth they became later necrotic. We designated those tumor-like formations as "Deciduomata" or "Placentomata" and placed them among a category of new formations which we characterized as "transitory tumors."[2] Other investigators showed later that the corpus luteum was furthermore of significance for the periodic growth of the mammary gland, especially also during pregnancy.

These facts suggested a possible importance of the corpus luteum for the spontaneous development of cancer in mice. Accordingly, we undertook in conjunction with Miss A. E. C. Lathrop in Granby, experiments in this direction. Several lots of female mice of various ages belonging to strains rich in tumors were castrated, while other normal mice of the same strains were kept as controls. In other experiments a certain number of mice belonging to strains of known cancer incidence were prevented from breeding and thus the influence of the non-occurrence of pregnancies was tested. Under the latter condition the possible influence of a corpus luteum was not entirely abolished, but merely diminished. We wish to state briefly the results so far obtained: Castration of mice at or below the age of 6 months (corresponding to a period of life when the animals are already sexually mature) diminished the cancer incidence in a very pronounced way. The cancer rate fell from 60 per cent. to 70 per cent. in normal mice to 9 per cent. in castrated mice. Castration above the age of 6 months has so far been without any noticeable effect.

Non-breeding mice develop cancer in a somewhat smaller percentage of cases and at a somewhat higher age than normal breeding mice. The influence of prevention of breeding is therefore much less marked than the effect of castration, but considering the large number of mice we used it is not probable that the differences which we actually did observe were accidental. However, we are continuing our experiments in various directions and if accidental factors should complicate some of our results, this will become apparent during the further development of our work. We established thus two sets of factors in the etiology

used by Tyzzer (which was subsequently also used by T. A. Murray) could, however, not be depended upon to give decisive results.

[2] Loeb, L., *Centralbl. f. allg. Pathol.*, XVIII., 1907, 563, and a series of papers in the *Archiv f. Entwicklungsmechanik*.

of cancer (1) hereditary factors, and (2) chemical actions exerted by an internal secretion.

We could show that the hereditary factors are not identical with the internal secretion and do not act by changing the number of corpora lutea and their activity, but that their point of attack is somewhere else. It appears probable that with the cooperation of hereditary conditions all those internal secretions are factors in the origin of cancer which initiate or sustain continuous or periodic growth processes. In other cases mechanical stimulation of growth may take the place of chemical stimulation and again in others a combination of both may be present. Whether in addition to these factors definitely established there is still another factor (microorganisms?) present, and which relation this last-named hypothetical factor bears to the other two factors are at present unknown. But whether or not such an additional factor enters, we can be certain that the two first named sets of factors are sufficiently strong to determine to a great extent the frequency of cancer in mice.

LEO LOEB

DEPARTMENT OF COMPARATIVE PATHOLOGY,
WASHINGTON UNIVERSITY

A NEW METHOD OF SELECTING TOMATOES FOR RESISTANCE TO THE WILT DISEASE

PERHAPS the most serious disease of tomatoes in the southern states is that caused by *Fusarium lycopersici*, the one that is commonly known as the tomato wilt. The causative fungus lives in the soil and attacks the plants through the roots and later grows up through the fibrovascular bundles into the stems. In common with similar diseases of other plants, such as the wilts of cotton, watermelon, etc., the only practical method of control now known is in the use of varieties, or strains, that are resistant to the disease. By saving seed from healthy plants in a badly infected field for several seasons, strains can be obtained which show considerable resistance to the disease. This method of selecting the strains, however, has several serious drawbacks: (1) A large acreage of tomatoes is required as a large percentage of the plants which are set in the field die with the wilt. (2) Many of the plants in the field do not come in contact with the wilt fungus during the season and so do not have a chance to show whether they are resistant to the disease. (3) Resistant plants in the field are readily pollinated by the susceptible plants. (4) The time necessary to obtain a wilt-resistant strain is too long.

While studying the disease in Louisiana, an attempt has been made to improve on our common method of selecting resistant plants by selecting in the seed bed. This has been accomplished by taking advantage of the fact that soil diseases infect plants better if the soil is first sterilized and then inoculated with a pure culture of the disease organism. In ordinary unsterilized garden soil, even if it is heavily inoculated with the tomato wilt fungus, not many of the plants will show the wilt to any extent before it is time to place them in the field. The presence of bacteria and other fungi seems to have an inhibitory effect on the wilt fungus. If, however, the soil is first sterilized by heat and then heavily inoculated with the wilt fungus just before planting, the disease will develop so well that most of the susceptible plants will be killed before they are large enough to be placed in the field. By growing the plants in this manner, only plants showing resistance are placed in the field. This saves a great deal of field space and also allows a selection from an almost unlimited number of plants. This also assures the presence of the wilt fungus on the roots of every plant.

To show how this method of selection works in practise, results of some experiments may be briefly given. Having by the old method of selection obtained a strain that showed considerable resistance to the wilt disease, this was compared by the seed bed method with three standard varieties of tomatoes. The seed of each variety were planted side by side in reinoculated sterilized soil. Different cultures of the fungus from different localities were also used in order to see if they would affect the varieties differently. In the following

table are given the percentages of living plants and of wilt-free plants of each variety sixty-eight days after planting. Most of the living plants that were diseased could be told by an external examination, but for these results all living plants were cut and examined for the presence of the discolored fibrovascular bundles.

Variety.	Culture *A.*		Culture *B.*		Culture *C.*		Culture *D.*	
	Living, Per Cent.	Healthy, Per Cent.	Living, Per Cent.	Healthy, Per Cent.	Living, Per Cent.	Healthy, Per Cent.	Living, Per Cent.	Healthy, Per Cent.
Stone	35.3	11.8	75.0	55.0	44.7	25.5	71.4	57.1
Acme	14.3	0.0	42.9	28.6	31.3	21.9	65.8	31.6
Earliana......	32.3	3.2	63.5	36.5	37.3	17.7	96.0	70.0
Wilt-resistant	62.5	31.3	.818	56.8	68.2	34.1	95.1	78.0

This table shows the comparatively greater resistance of the wilt-resistant variety as compared to the others, and it also shows the large percentage of susceptible plants that could be eliminated before setting in the field.

Although the investigations on this method are far from complete, it seems well at this time to put it into the hands of other workers with the hope that it may be found useful.

C. W. EDGERTON
LOUISIANA AGRICULTURAL EXPERIMENT STATION,
BATON ROUGE, LA.

DO MOVEMENTS OCCUR IN THE VISUAL CELLS AND RETINAL PIGMENT OF MAN?[1]

THE statement is commonly found in text-books of gross[2] and microscopical[3] anatomy, as well as in some texts of physiology,[4] that the retinal pigment of the human eye undergoes positional changes in light and in darkness. The pigment, which, in the dark, forms a compact layer next to the choroid, is said to migrate towards the external limiting membrane in the light, thereby forming processes which interdigitate with the rods and cones. If not explicitly stated, it is at least implied that this response is well marked and the actual migration extensive.

This view is so generally accepted as expressing a commonplace of retinal physiology that it is well worth while to examine the facts upon which its validity rests.

That photomechanical changes take place in the retinal pigment of anuran amphibians, a fact first established independently by Boll[5] and by Kühne[6] on the frog in 1877, may be substantiated by any one who will perform the necessary experiments. Similar results, in many cases even more striking, were obtained on fishes (Stort, '86).[7] Angelucci ('78)[8] likewise first reported this condition to hold for *Triton* as a type of urodele amphibian, and Stort ('87),[9] using the pigeon for material, again presented the earliest demonstration in the retina of birds.

When reptiles and mammals are considered, on the other hand, the literature at once becomes contradictory. Angelucci ('90),[10] however, reported a rather limited pigment migration in the retina of *Testudo marina*, and Chiarini ('06)[11] also states that a distinct but

[1] Contributions from the Zoological Laboratory of the Museum of Comparative Zoology at Harvard College, No. 263.

[2] *E. g.*, R. Howden, 1913, in Cunningham's "Anatomy," 4th ed., p. 817. E. A. Spitzka, 1910, in Gray's "Anatomy," 18th ed., p. 1106. Piersol, G. A., 1906, "Human Anatomy," p. 1463.

[3] *E. g.*, Bailey, F. R., 1913, "Text-book of Histology," 4th ed., p. 556. Piersol, G. A., 1913, "Normal Histology," 10th ed., p. 348.

[4] *E. g.*, Halliburton, W. D., 1910, "Handbook of Physiology," 9th ed., p. 843. Starling, E. H., 1912, "Principles of Human Physiology," p. 680 (by implication).

[5] Boll, F., 1877, *Monatsber. d. k. preuss. Akad. d. Wiss. zu Berlin*, pp. 72–74.

[6] Kühne, W., 1877, *Untersuch. a. d. physiol. Inst. d. Univ. Heidelberg*, Bd. 1, pp. 15–103, Taf. 1.

[7] Stort, A. G. H., Van Genderen, 1886, *Bericht über d. 18. Versamm. d. Ophthal. Gesell. zu Heidelberg*, pp. 43–49.

[8] Angelucci, A., 1878, *Arch. f. Anat. u. Physiol., Physiol Abt.*, pp. 353–386.

[9] Stort, A. G. H., Van Genderen, 1887, *Arch. néérland. d. Sci. exact et nat.*, Tom. 21, pp. 316–386.

[10] Angelucci, A., 1890, *Untersuch. z. Naturlehre d. Menschen u. d. Thiere*, Bd. 14, pp. 231–357.

[11] Chiarini, P., 1906, *Arch. ital. de Biol.*, Tom. 45, pp. 337–352.

limited pigment expansion was observed in the light-adapted eyes of the lizard.

With the exception of the early results of Angelucci ('78), who maintained that definite pigment movements occur in the rabbit, there exists only one positive record for mammals—that of Chiarini ('06), describing slight changes in the retina of dogs which had been exposed to direct sunlight and to darkness. The pigment of the light-adapted animals extended in short fringe-like processes between the rods, in contrast to the densely contracted pigment of the reciprocal set. Finally, Garten ('07)[12] carried out carefully executed experiments upon the ape, ox, rabbit and rat, yet failed to observe any striking differences between the effects of light and darkness; however, in the retina of the ape, which has a minute amount of pigment, composed of needle-like granules, the pigment was extended 3 to 4 granules deep in the light and only 2 to 3 granules deep in the dark.

When, in connection with experimentation upon the retinal pigment and visual cells of certain lower vertebrates, it became necessary to review the literature of this subject, I was at once impressed with the discrepancy between the statements found in many standard texts and the actual status of our knowledge, which, I believe, has been correctly summarized in the preceding paragraphs.

That slight positional changes due to photic stimulation have been detected in the retinal pigment of certain mammals, is probably true, but no evidence has yet been presented to show that a like condition holds for man. Moreover, if, in the future, such responses are demonstrated, the results upon other mammals (cf. Garten's experimentation upon apes) would lead us to expect them to be extremely limited. Since it follows, therefore, that the loose phraseology and the misstatements to be found in many standard text-books necessarily create fundamentally wrong impressions in the mind of the reader, it is evident that the future editions of all offending texts should avoid lending aid to the perpetuation of this popular misconception.

[12] Garten, S., 1907, "Graefe-Saemisch, Handb. d. gesam. Augenheilkunde," Bd. 3, Kap. 12, Anhang.

A phenomenon related to that of pigment migration is the contractility exhibited by a definite portion of the inner member of rods and cones. The so-called "myoid" of the cone-visual cell shortens to a marked degree when, in the case of many fishes and of some amphibians and birds, the retina is exposed to light. Among reptiles and mammals, changes in the length of the cone myoid are hard to observe, yet in both groups responses to light have apparently been detected in a few instances.

Among mammals, the results of Stort ('87) on the pig stand alone in ascribing striking positional changes to the cones; Stort's measurements of one dark-adapted human eye, moreover, do not prove that movements of the cones occur in man. Chiarini ('06) obtained negative results on the dog's eye, although Garten ('07), by careful experimentation upon apes, has been able to demonstrate slight changes in the region of the fovea. The assumption, on the part of writers, of the occurrence of movements in the cones of man has been relatively rare.

The rod myoids of certain fishes, amphibians and birds are likewise responsive when stimulated by light, yet nothing has been recorded concerning the existence of this phenomenon in mammals.

It is possible, as Garten ('07) suggests, that the changes in the retinal pigment and visual cells of mammals occur so quickly that the fixing fluids through slowness of penetration fail to preserve them in an extended condition.

LESLIE B. AREY

THE CONVOCATION WEEK MEETINGS OF SCIENTIFIC SOCIETIES

THE American Association for the Advancement of Science and the national scientific societies named below will meet at Columbus, Ohio, during convocation week, beginning on Monday, December 27, 1915:

American Association for the Advancement of Science.—President Dr. W. W. Campbell, Director Lick Observatory; retiring president, Dr.

Charles W. Eliot, Harvard University; permanent secretary, Dr. L. O. Howard, Smithsonian Institution, Washington, D. C.; general secretary, Mr. Henry Skinner, Academy of Natural Sciences, Logan Square, Philadelphia, Pa.; secretary of the council, Professor W. E. Henderson, Ohio State University.

Section A—Mathematics and Astronomy.—Vice-president, Professor A. O. Leuschner, University of California; secretary, Professor Forest R. Moulton, University of Chicago, Chicago, Ill.

Section B—Physics.—Vice-president, Professor Frederick Slate, University of California; secretary, Dr. W. J. Humphreys, U. S. Weather Bureau, Washington, D. C.

Section C—Chemistry.—Vice-president, Professor W. McPherson, Ohio State University; secretary, Dr. John Johnston, Geophysical Laboratory, Washington, D. C.

Section D—Mechanical Science and Engineering.—Vice-president, Bion J. Arnold, Chicago; secretary, Professor Arthur H. Blanchard, Columbia University, New York City.

Section E—Geology and Geography.—Vice-president, Professor C. S. Prosser, Ohio State University; secretary, Professor George F. Kay, University of Iowa.

Section F—Zoology.—Vice-president, Professor V. L. Kellogg, Stanford University; secretary, Professor Herbert V. Neal, Tufts College, Mass.

Section G—Botany.—Vice-president, Professor W. A. Setchell, University of California; secretary, Professor W. J. V. Osterhout, Harvard University, Cambridge, Mass.

Section H—Anthropology and Psychology.—Vice-president, Professor G. M. Stratton, University of California; secretary, Professor George Grant MacCurdy, Yale University; New Haven, Conn.

Section I—Social and Economic Science.—Vice-president, Geo. F. Kunz, New York; secretary, Seymour C. Loomis, 69 Church St., New Haven, Conn.

Section K—Physiology and Experimental Medicine.—Vice-president, Professor F. P. Gay, University of California; secretary, Professor C.-E. A. Winslow, Yale University.

Section L—Education.—Vice-president, Professor E. P. Cubberley, Stanford University; secretary, Dr. Stuart A. Courtis, Detroit, Mich.

Section M—Agriculture.—Vice-president, Professor Eugene Davenport, University of Illinois; secretary, Dr. E. W. Allen, U. S. Department of Agriculture, Washington, D. C.

COLUMBUS

The American Physical Society.—December 28–30. President, Professor Ernest Merritt, Cornell University; secretary, Professor A. D. Cole, Ohio State University, Columbus, Ohio.

The American Federation of Teachers of the Mathematical and the Natural Sciences.—Secretary, Dr. Wm. A. Hedrick, McKinley Manual Training School, Washington, D. C.

The American Society of Naturalists.—December 30. President, Professor Frank R. Lillie, University of Chicago; secretary, Dr. Bradley M. Davis, University of Pennsylvania, Philadelphia, Pa.

The American Society of Zoologists.—December 28–30. President, Professor William A. Locy, Northwestern University; secretary, Dr. Caswell Grave, The Johns Hopkins University, Baltimore, Md.

The Entomological Society of America.—December 29–31. President, Professor Vernon L. Kellogg, Stanford University; secretary, Professor Alexander D. MacGillivray, 603 West Michigan Ave., Urbana, Ill.

The American Association of Economic Entomologists.—December 27–30. President, Professor Glen W. Herrick, Cornell University; secretary, A. F. Burgess, Melrose Highlands, Mass.

The Botanical Society of America.—President, Professor John M. Coulter, University of Chicago; secretary, H. H. Bartlett, 335 Packard St., Ann Arbor, Mich.

The American Phytopathological Society.—December 28–31. President, Professor H. H. Whetzel, Cornell University; secretary, Dr. C. L. Shear, U. S. Department of Agriculture, Washington, D. C.

American Nature-Study Society.—December 30–31. President, Dr. L. H. Bailey, Ithaca, N. Y.; secretary, Professor E. R. Downing, University of Chicago, Chicago, Ill.

School Garden Association of America.—December 29–30. President, Van Evrie Kilpatrick, 124 West 30th St., New York, N. Y.

American Association of Official Horticultural Inspectors.—December 28–29. Chairman, W. E. Rumsey, Morgantown, W. Va.; secretary, Professor J. G. Saunders, State Capitol, Madison, Wis.

The American Microscopical Society.—December 29. President, Professor Chas. A. Kofoid, University of California; secretary, T. W. Galloway, James Millikin University, Decatur, Ill.

American Mathematical Society (Chicago Section).—December 30 to January 1. Chairman, Professor E. J. Wilczynski, University of Chicago; secretary, Professor H. E. Slaught, 5548 Kenwood Avenue, Chicago, Ill.

The Southern Society for Philosophy and Psychology.—December 28–30. President, Professor J. C. Barnes, Maryville College; secretary, Professor L. R. Geissler, University of Georgia, Athens, Ga.

Botanists of the Central States.—Will hold no separate meeting, but will present its papers in connection with Section G. President, Professor H. C. Cowles, University of Chicago; secretary, Dr. Edward A. Burt, Missouri Botanical Garden, St. Louis, Mo.

Society for Horticultural Science.—December 28–29. President, W. L. Howard; secretary, Professor C. P. Close, College Park, Maryland.

Association of Official Seed Analysts of North America.—December 28 and 29. President, W. L. Oswald; secretary, John P. Heylar, Agricultural Experiment Station, New Brunswick, N. J.

Society of Sigma XI.—December 28. President, Chas. S. Howe, Case School; secretary, Professor Henry B. Ward, University of Illinois, Urbana, Ill.

BOSTON

The American Physiological Society.—December 27–29. President, Professor W. B. Cannon, Harvard Medical School, Boston, Mass.; secretary, Professor Chas. W. Greene, University of Missouri, Columbia, Mo.

The American Society of Biological Chemists.—December 27–30. President, Professor Walter Jones, The Johns Hopkins University; secretary, Professor Philip A. Shaffer, Washington University Medical School, St. Louis, Mo.

The Society of Pharmacology and Experimental Therapeutics.—December 27–29. President, Dr. Torald Sollmann, Western Reserve University Medical School, Cleveland, Ohio; secretary, Dr. John Auer, Rockefeller Institute for Medical Research, New York City.

WASHINGTON, D. C.

The Geological Society of America.—December 28–30. President, Professor A. P. Coleman, University of Toronto; secretary, Dr. Edmund Otis Hovey, American Museum of Natural History, New York City.

The Association of American Geographers.—December 30–January 1. President, Professor R. E. Dodge, Teachers College, Columbia University; secretary, Dr. Isaiah Bowman, Broadway and 156th St., New York City.

The Paleontological Society.—December 29–30. President, Dr. E. O. Ulrich, U. S. Geological Survey; secretary, Dr. R. S. Bassler, U. S. National Museum, Washington, D. C.

The American Anthropological Association.—December 27–31. President, F. W. Hodge, Bureau of American Ethnology; secretary, Professor George Grant MacCurdy, Yale University, New Haven, Conn.

The American Folk-Lore Society.—Convocation Week. President, Dr. P. E. Goddard, American Museum of Natural History, New York City; secretary, Dr. Charles Peabody, 197 Brattle St., Cambridge, Mass.

The American Economic Association.—December 28–30. President, Professor W. F. Willcox, Cornell University; secretary, Professor Allyn A. Young, Cornell University, Ithaca, N. Y.

The American Sociological Society.—December 28–31. President, Professor E. A. Ross, University of Wisconsin; secretary, Professor Scott E. W. Bedford, University of Chicago, Chicago, Ill.

NEW HAVEN

The Association of American Anatomists.—December 28–30. President, Professor G. Carl Huber, University of Michigan; secretary, Dr. Charles R. Stockard, Cornell University Medical School, New York City.

URBANA

The Society of American Bacteriologists.—December 28–30. President, Dr. D. H. Bergey, University of Pennsylvania; secretary, Dr. A. Parker Hitchens, Glenolden, Pa.

NEW YORK CITY

The American Mathematical Society.—December 27–28. President, Professor E. W. Brown, Yale University; secretary, Professor F. N. Cole, 501 West 116th St., New York City.

CHICAGO

The American Psychological Association.—December 28–30. President, Professor John B. Watson, The Johns Hopkins University; secretary, Professor R. M. Ogden, University of Kansas, Lawrence, Kansas.

PHILADELPHIA

The American Philosophical Association.—December 28–30. President, Professor A. C. Armstrong, Wesleyan University; secretary, Professor E. G. Spaulding, Princeton, N. J.

SCIENCE

FRIDAY, DECEMBER 31, 1915

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FRUITS, PROSPECTS AND LESSONS OF RECENT BIOLOGICAL SCIENCE[1]

THE general welfare of mankind has been wonderfully promoted during the past 150 years by the rapid progress of chemical, physical, and biological science. In the early third of that period, physics and chemistry and their applications seem to have played the most active parts in promoting human welfare, although pure botany and zoology enlisted many devoted workers, and made great advances; but during the past 100 years it is biological science that has contributed most to the well-being of humanity. The new methods of transportation and of manufacturing by the aid of machinery with steam as motive power were products of applied physics. So were the great works of civil and mechanical engineering. The improved agriculture of the last half of the nineteenth century was partly due to new tools and machinery, and partly to new applications of chemical knowledge. Latterly biological science has helped the farmer very much to raise better crops and animals, and to protect his products from vegetable and animal pests.

While the industrial and social changes, which applied physics and chemistry made possible, unquestionably improved the general condition of mankind as regards bodily comfort, security against natural catastrophes, longevity, and an increased sense of mutual support and community interest through the vast improvement in the means of communication, these changes

[1] Address of the retiring president of the American Association for the Advancement of Science, given at the Columbus meeting, December 27, 1915.

have all been *indirect* influences on human well-being and happiness, and with the good they brought much evil was mixed. Thus, the factory system, the congestion of population, and the noise and turmoil of city life are grave evils accompanying the advantages which applied physics and chemistry have created and diffused. The fruits of the biological sciences—botany, zoology, physiology and biochemistry, applied to curative medicine and surgery and to preventive medicine and sanitation—have been *direct* contributions to human welfare; because they have provided defenses against disease, premature death, and individual and family distress and suffering. The beneficent applications of biological science, unlike most of the large results of applied chemistry and physics, take effect in the field of human affections and family experiences, make life less anxious and more enjoyable for multitudes of human beings, mitigate or abolish ancient agonies and dreads of the race, and promise for it a happier future.

The career of Pasteur illustrates admirably the passing of the center of beneficent scientific research from chemistry and physics to biological science. Pasteur's first researches were crystallographic; whence he passed to the study of molecular dissymmetry, the material of his researches being, however, organic. He was first professor of physics and then professor of chemistry. His interest in certain tartrates led him naturally, though partly by accident, to a study of fermentation. His zealous discharge of his duties as Dean of a Faculty of Sciences at Lille, a manufacturing center, led to his study of beet-root juice, fermented in order to produce alcohol. Thereafter Pasteur's researches were biological, although he had had no training as either naturalist or physician. He began at the foundation by disproving the doctrine of spontaneous generation. One of his earliest conclusions was that "gases, fluids, electricity, magnetism, ozone, things known or things occult, there is nothing in the air that is conditional to life except the germs it carries." Of his earliest results from experiments on admitting pure air to flasks containing putrescible infusions he wrote:

> It seems to me that it can be affirmed that the dusts suspended in atmospheric air are the exclusive origin, the necessary condition of life in infusions;

and in the same paper he made the pregnant remark:

> What would be most desirable would be to push those studies far enough to prepare the road for serious research into the region of various diseases.

He lived to push his studies into the causes of the silk-worm disease, of a cholera which came from Egypt into France, of the plant diseases affecting the manufacture of wine and of beer, of the splenic fever, of the chicken-cholera, and of rabies; and he and his followers invented successful treatment for those diseases, and for the treatment of typhoid fever and diphtheria. The germ and parasite theory of disease led the way in serum therapy, and established both the philosophy and the practise of the new medicine and surgery of the past thirty-five years. Starting with a sound knowledge of chemistry and physics, and having early acquired a habit of utmost accuracy in observing and reasoning, Pasteur passed over into biological science by the time he was thirty-two years of age, and became the most suggestive and productive inventor and promoter in applied biology that has ever lived. His career illustrates conspicuously the general truth that the sciences most serviceable to mankind during the past sixty years have been the biological sciences. In a letter to his father in

1860, when his inquiries were opening new vistas in physiology, Pasteur wrote:

> God grant that by my persevering labors I may bring a little stone to the frail and ill-assured edifice of our knowledge of those deep mysteries of life and death, where all our intellects have so lamentably failed.

That prayer was granted.

Let us review in a summary way the fruits of applied biological science since the nineteenth century opened.

The first invention, vaccination against smallpox, long antedated the later studies of germs, parasites, the routes of disease from one human being to another through insects and other animals, and the theory and practise of immunity. Vaccination, the invention of a country doctor who practised in a dairy district, was a momentous discovery in immunity from a fatal and disfiguring disease which was frequently epidemic, the immunity being procured by causing in the human body another disease very seldom fatal and not at all disfiguring. The favorable reception and rapid application of Jenner's discovery were due to the fact that many persons at that time protected themselves against the frequent and terrible epidemics of smallpox by being inoculated with smallpox itself. So soon as it was proved that cowpox gave immunity in almost all cases against smallpox, inoculation with cowpox came rapidly into use; because inoculated cowpox proved to be, as one of Jenner's contemporaries remarked, "a pleasanter, shorter, and infinitely more safe disease than inoculated smallpox." The relief of civilized mankind from the terrible recurrent epidemics of smallpox is one of the greatest benefits that the profession of medicine has conferred on the human race.

From biological studies largely on microscopic organisms—protozoa, bacteria, and parasitic growths—the means of communication from one human being to another or from an animal to man of dysentery, cholera, typhoid fever, typhus fever, puerperal fever, bubonic plague, diphtheria, tuberculosis, cerebro-spinal meningitis, syphilis, gonorrhoea, sleeping sickness, yellow fever, malaria, and hookworm disease have all been brought to light. Means of preventing or restricting the spread of these diseases—with the exception of cerebro-spinal meningitis—have been invented, and for most of them improved methods of treatment have been devised. Much has also been learnt about infantile paralysis, and something about cancer. The whole subject of toxins and anti-toxins has been developed with wonderfully beneficent results.

It is really impossible to describe or appreciate the alleviations and preventions of human misery included in this list of the fruits of applied biological science. Some of the diseases mentioned were within a few years familiar household terrors in the most civilized countries, others from time to time destroyed in recurring epidemics large portions of the population in many parts of the world. They terrorized families and nations, made innumerable homes desolate, and ruined for a time cities and states. The generations now on the stage can hardly appreciate the formidable apprehensions from which their predecessors suffered, but they themselves have been relieved by the achievements of medical research and preventive medicine. This blessed preventive medicine may almost be said to have been created by the combination of bacteriological and pathological studies, which are all, of course, biological studies. Physiology has been wonderfully developed as a study of biological processes by the addition of bacteriological experimentation to

its former chemical and physical methods of research.

Public health boards have been established and equipped to perform under new laws numerous functions which had no existence until applied biology with aid from chemistry and physics indicated the desirable modes of public action. The boards, or public health commissioners, prescribe, teach and enforce rules and orders concerning personal, industrial, farm and dairy, and school hygiene, social hygiene including venereal prophylaxis for individuals and families, the preservation of foods and their protection from infection, the effects of various industries on the health of employees, the connection of syphilis with insanity and general paresis, and of gonorrhea with blindness, procure vital statistics, establish registration of births and deaths, and of cases of disease, study epidemics and infant mortality, and contend against dangerous contagious diseases by quarantines, isolation, disinfection, and the destruction of the insect and vermin carriers of disease. All these activities have been completely dependent on applied biology for their methods and processes, and have changed and developed rapidly with the progress of that science. Taken together they constitute an immense contribution to human welfare, present and future.

It is animal experimentation with the help of anesthesia and asepticism which has given mankind by far the larger part of all the exact knowledge of medicine now possessed, and promises still greater serviceableness in the future. In the service of man new studies have been made, not only of microscopic plants and animals, but of many larger creatures which live with man, such as poultry, rabbits, guinea pigs, cats, dogs, cattle, horses, mules and monkeys, and of many insects, such as flies, ticks, mosquitoes, and lice which infest the fauna and flora which surround man, or the bodies or clothes of men themselves. An immense mass of biological information on all these subjects has been accumulating during the past two generations, and is growing rapidly from year to year, as the good results of such studies become better known.

These results bear directly on the well-being and happiness of the human race, but also indirectly on the economic and commercial fortunes of the race. Through the well-directed efforts of the Rockefeller Sanitary Commission hundreds of thousands of persons in the Southern States of this country have, within the last five years, been made much more effective laborers, because relieved of the hookworm disease; and this good work is now being extended by the International Health Commission—one of the departments of the Rockefeller Foundation—to the West Indies, Central America, Ceylon, and the Straits Settlements. The work of this Commission has three divisions: (1) the Commission makes surveys of regions where hookworm disease is prevalent; (2) then it cures multitudes of sufferers by active and persistent treatment; and (3) it teaches people by the thousand how to prevent the recurrence of the disease in farming communities by using privies and wearing shoes. In the last two processes it tries—often successfully—to enlist existing public authorities and the taxing power in the work, in order to give it permanence. All this beneficent action is fruit of biological research. It would have been impossible to dig the Panama Canal, without the effective control over yellow fever and malaria which biological science has given to the race within a single generation. Two humane contributions to military efficiency during the Great War

are results of biological research applied to sanitation, one the prevention of epidemics of fever and cholera in the camps and trenches in Western Europe, and the other the quick arrest of a terrible epidemic of typhus fever in Serbia.

Let us next take account of the prospects of applied biology in the coming years. May we anticipate for it an increasing or a decreasing influence?

The progress of medical and surgical research during the past twenty years is of great promise for the future. It goes on actively in every good medical school, in many hospitals and dispensaries, and in the new institutes exclusively devoted to research. It is strongly supported by the new tendency to maintain in medical schools professorships of comparative anatomy, physiology and pathology. The importance of comparative pathology is just coming to be recognized. Inasmuch as animal experimentation, with the help of anesthesia and asepticism, is nowadays the principal means of extending the knowledge of the causes of disease and of the means of remedy and prevention, the importance of comparative studies on many species of animals, including man, has become obvious to all persons who think about the improvement of the human race and of its useful animal associates.

In regard to the treatment of contagious diseases, the story of the recent past can not but suggest hopes of even more rapid progress in the future towards the effective control of some of the worst diseases that afflict humanity. Thus, in the ten years from 1903 to 1913 syphilis was transmitted artificially to certain lower animals; the characteristic bacillus of that disease was discovered; the Wasserman test was invented, a test which enables an expert in its use to detect those cases which have no external symptoms; the value of salvarsan, as a safe destroyer of the bacillus within the human body, was demonstrated; and the bacillus was grown in pure culture outside of the body, whence resulted luetin, an important aid in the diagnosis of obscure cases; and finally the bacillus was detected in the brain of patients suffering from general paresis, and in the spinal cord of patients with locomotor ataxia. This series of discoveries and inventions has given to man a much improved control over this terrible scourge; but this control is not yet applied on an adequate scale. It remains for the future to cause this destructive disease to be early recognized, reported, and effectively dealt with. It is for state and municipal boards of health to invent and put into practise the means of contending against the spread of this horrible disease. This is a public health problem of the gravest sort. That public health authorities may succeed in the future against the horribly destructive effects of syphilis on every civilized race in the world is one of the hopes of the future, a hope inspired by the recent progress of biological science.

The progress of bio-chemistry and bacteriology has already enabled civilized governments to do much for the protection of their people from injury by foods not fit for consumption and by adulterated drugs. This is a branch of the public health service which is capable of large extension hereafter. The efficiency of the methods now used will be greatly increased; and they will be used in new fields. It is more than forty years since the Massachusetts Board of Health gave effective attention to the transportation and slaughtering of animals intended for food, an admirable piece of pioneering which brought about great improvements,

and served as a basis for further measures of defense for the community. The common use of cold-storage for meats, vegetables and fruits has lately increased the need of protection against damaged foods; and this cold-storage process is likely to be more and more used in the future—quite legitimately—for the preservation of perishable foods produced in greater quantity than can be sold at or near the time of their production. A cold-storage plant performs as to foods the function of the reservoir in an irrigation plant. Both urban and rural communities have much to hope in the future from cold-storage and irrigation; but to both these public utilities applied biological science must contribute indispensable precautions. There are climates in which extensive irrigation is liable to produce and perpetuate pestiferous insects.

One of the most favorable results of applied biology during the past fifty years is the great addition made to the means of detecting the true causes of abnormal conditions of the human body, and to the accuracy of diagnostic reasoning on both acute and chronic disorders. These new means of diagnosis and examination are in part chemical and physical, but chiefly biological. The theory and practise of asepsis are results of biological researches. Comparative anatomy, physiology and pathology all contribute largely to modern sanitation and to all the practises of boards of health for the discovery and prevention of unsanitary conditions in both urban and rural communities. Very promising examples of these useful practises are: the precautions nowadays taken against contagious disease in schools, the employment of school nurses, the inspection of school children's teeth, eyes, noses, ears and skin, the discovery in the mass of school children of the defective, the feeble-minded, and of those suffering from glandular abnormalities, particularly in the nose, mouth, and throat. The effective treatment of school children following on the detection of their disorders or defects promises much toward the better health of the coming generations. The successful use of the Schick test which enables the physician through a laboratory expert to separate the susceptible from the non-susceptible individuals who have been exposed to diphtheria, and therefore to avoid all unnecessary administrations of antitoxin, seems to open a wide prospect in the study of natural immunity. The process of improvement is not going to stop; on the contrary it will advance at an accelerated pace.

Another great field for applied biological science in the future is the contest against alcoholism and sexual vice. This is an important part of the province of social hygiene, a province which includes the philanthropic and economic treatment of the feeble-minded, the insane, the paralyzed, and the blind. The field is enormous; and its evils are intimately connected one with another; but in the whole field the means of cure and prevention have come in the main from biological research. There is every reason to expect that this great field for Christian effort will hereafter be more effectually cultivated than it has ever been.

In connection with the medical, surgical, and sanitary activities of the present day, new forms of educational effort have been instituted which are very promising for the future health and comfort of mankind. Thus, the institution of district nursing has already developed strong educational effects. The district nurse goes from house to house to treat and comfort individual patients suffering from various disorders; but in every house she also teaches the mother, sister, or some other attendant on

the sick or injured person, how to perform herself the remedial operations, how to feed the patient, and how to prevent the communication of the disease to other persons; and this teaching function of the nurse is quite as important as her curative or comforting ministrations. The social worker who follows up the out-patients of a great hospital, sees them at their homes, studies their surroundings, and gives them sympathetic counsel, has a similar teaching function, which often takes strong effect on whole families and even larger groups. Like the district nurse, she also frequently obtains family histories which are of value to students of inheritance, good or bad, and of eugenics. The same is true of the school nurse and medical inspectors who are employed by American cities in which the health department is strong and well-organized. These nurses and doctors not only detect defects and diseases in school children, but indicate to parents or friends the remedial measures that are demanded, and give much instruction to parents and guardians about keeping children well. The same educational function is performed by the dentists who are being employed in a few American cities to make periodical inspections of the teeth of school children. These large-scale examinations and teachings call for knowledge of bacteriological information and methods only recently acquired, and for skill in the use of diagnostic tools and appliances only recently invented. These new applications of biological science promise great reduction of human suffering and distress, and significant additions to average longevity and average efficiency, so soon as they come into general use.

Biological science has made possible several other kinds of widespread teaching which are certain to have beneficial effects on the productiveness of human labor, particularly in agriculture, the fundamental industry. Thus, the whole work of the International Health Commission is essentially educational. It teaches the people in hookworm disease districts by demonstration, first, that they have the disease; secondly, that it can be cured in the individual and eradicated from the community; and thirdly, that the embryos of the disease live by thousands in soil that has been befouled by an infected person, and are there ready to infect any person with whose bare, soft skin they come into contact. These demonstrations combined teach the people how the disease may be avoided in the future by an individual or by a community. As a result of this educational work, the common people and the health authorities cooperate effectively in both the work of treatment and that of prevention.

Another illustration of the broad educational processes now at work in consequence of the achievements of applied biology is to be found in the short courses given by many state universities to farmers and their grown-up sons on the principles of agriculture, the choice of seeds, and stock-raising, and in the itinerant teaching for adults now carried on by the U. S. Department of Agriculture throughout the Southern States on similar subjects. This instruction is supplemented by the offer of prizes, and the setting-up of model farms, or model acres, in great number as lessons and incitements to neighborhoods. The effects on the productiveness of American agriculture, especially in cotton and corn, are already remarkable; but the promise of these educational methods for the future is more precious still. Several colleges and universities of high standing now provide short courses which run from six to twelve weeks, some in winter and some in summer, expressly

to prepare teachers or leaders for Girls' Canning Clubs and Home Demonstration Work. These courses cover cooking, canning, sewing, market gardening, poultry husbandry, plant propagation, and rural sanitation. Their good effects have been quickly demonstrated on a large scale.

Boards of health in several American municipalities and states have lately undertaken a large work of public teaching by means of widely distributed posters and leaflets on contagia and the carriers of contagious disease. They have found themselves obliged to take this action, because they learnt by experience that the spread of contagious disease can not be prevented by enacting laws and employing inspectors to procure the execution of those laws, unless the citizens themselves cooperate actively and with intelligence in the execution of the measures which applied biology prescribes. Thus, the public at large must be taught that if streets, yards, and vacant lots of a city are kept clean, garbage is removed promptly and kept covered till removed, and the privy vault and the manure-heap are abolished, the number of flies and vermin in and about dwellings will be much reduced. Reduction in the amount of sexual vice and venereal disease can be effected by teaching parents and young people about the dangers of syphilis and gonorrhea for the individual, and their fatal effects on family happiness.

Thirdly, this immense development of biological knowledge and skill must have lessons to teach about the means of other progress, similar or contrasted.

The most important lesson which the great advance in applied biological science teaches is that the treatment of human evils and wrongs in the future should be preventive for the mass, as well as curative for the individual. This is the reason for the great change which is taking place in the profession of medicine. The main functions of that profession are to be, not the curing of individuals who are already suffering from disease, but the prevention of the spread of disease from individual to individual in the community, and the eradication or seclusion of the causes, sources, or carriers of communicable diseases. The same great change needs to be wrought in all the callings which deal with prevention of crimes and misdemeanors. Society must concern itself, not chiefly with the isolation, temporary or permanent, of the individual murderer, thief, or forger, but with the extermination or repair of the genetic, educational, or industrial defects which cause the production of criminals. Since it is often found through medical and psychological examination that the prostitute, forger, robber or poisoner is physically as well as morally defective, it is probable that biological science will in the future contribute largely to the prevention as well as cure of such bodily defects, and hence of those moral defects which in an appreciable fraction of the population result in crimes. When humane persons learn, for example, that three fifths of all the prostitutes in New York City are feeble-minded girls and women, they become interested at once in the better care and treatment under medical direction of the feeble-minded, in the means of making a trustworthy diagnosis of feeble-mindedness in children, and in preventing the feeble-minded from reproducing their like. These are all biological problems; and the progress of biological inquiry during the past fifty years is sufficient to afford the means of solving on a large scale these fundamental social problems. It is to biological science in the departments of men-

tal disease and psycho-therapy, as well as to educational theory and practise, that we must look for new methods of discipline and education in prisons, reformatories, and houses of correction. Preventive medicine and sanitary reform have shown the right way of dealing with these chronic sores in the body politic.

The interrelations of the sciences are vividly taught by the history of biology during the past eighty years. Biological science is deeply indebted to physical science for the new instruments of precision which the biologist uses in determining and recording his facts. The telephone, the x-ray, and all the electrical apparatus for recording fluent observations and making certain note of very minute portions of time and space have been invaluable additions to the resources of the biological investigator. Many of the instruments which are indispensable in botanical and zoological laboratories were not invented for biological uses, but for physical or chemical uses. The dental practise called orthodontia has profited greatly by the use of the x-rays, because the Roentgenograph exhibits the precise abnormalities in the jaws and the concealed teeth which need to be remedied. The art of photography has contributed much to biological research and biological teaching, although developed and improved more for commercial and astronomical purposes than for biological. The microscope itself and the immersion lens, tools indispensable in the study of microorganisms of all sorts, were long used in pure botany and zoology, before they became the necessary tools of applied biological science.

Again, the long series of successful applications of biological science illustrates strikingly the impossibility of drawing any fixed line of demarcation between pure and applied science, or of establishing an invariable precedence for one over the other. Sometimes an application is suddenly made of one fragment of an accumulation of knowledge which pure scientists have made without thought of any application; and sometimes a bit of knowledge successfully applied stimulates pure scientists to enter and ransack the field from which the bit came. The latter process was strikingly illustrated when the large group of the mosquitoes was studied with ardor, because two species became famous, one as the carrier of malaria, and the other of yellow fever. The anatomy and habits of the typhus fever louse had been worked out many years before that insect became known as a carrier of typhus fever. Long before salvarsan was proved valuable for killing the syphilis microorganism in the human body, a series of organic compounds derived from benzol and containing arsenic had been elaborately studied, and the means of producing them made known by chemists who had not the faintest suspicion that a safe remedy for the most destructive of contagious diseases in the human species was later to be found in a new member of the series having a reduced arsenical potency. The pure scientist often feels, and not infrequently expresses, contempt for applications of science and for the men that make them. Sometimes the seeker for valuable applications of scientific knowledge feels no interest whatever in researches of which no industrial application seems feasible or probable, and confesses publicly this lack of interest. The facts seem to be that all such feelings are narrow and irrational; that no mortal can tell how soon a practical application of a scientific truth, which seems pure in the sense that it has no present application, may be discovered; and that, on the other hand, innumerable applications are nowadays made of truths

which five years or fifty years ago seemed as remote from all human interests as the observation attributed to Thales, that a bit of amber rubbed with a piece of silk would repel pith-balls suspended by fine filaments. Yet all magnetism and electricity with their infinite applications hark back to this experiment by Thales and to Galvani's observation of twitchings in a frog's legs.

The new physiological studies of the bodily changes accompanying or produced by pain, hunger, fear, and rage already promise a new interpretation of human behavior, and therefore a new policy for human society in regard to those emotions which, from primitive times to the present day, have been the source of enormous evils to mankind. The bodily changes which in man accompany these powerful emotions have only recently been in part made known; but it has already been made out with regard to a group of these alterations in the bodily economy that they may be regarded as responses adapted to preserve the individual, and to promote his bodily welfare or his efficiency. The emotions which a man fighting experiences call into sudden and potent action the muscular and nervous forces which he needs for both offense and defense. Hunger is a highly protective sensation. Fear stimulates muscular and nervous exertion, so long as the frightened animal can flee; but, if the animal is cornered, fear turns to fury, which develops the extraordinary strength of desperation. The successful study to-day of these bodily changes and reactions prophesies a better understanding in the future of the moral forces which make for rational conduct, and of the public policies in regard to war and peace which, long pursued, may gradually affect the sum of human misery or of human happiness.

The present terrible condition of Europe and the coincident sufferings of much of the rest of the world give fresh significance to the following remarks of Louis Pasteur at the inauguration of the Pasteur Institute at Paris in 1888:

Two contrary laws seem to be wrestling with each other nowadays—the one a law of blood and of death, ever imagining new means of destruction, and forcing nations to be constantly ready for the battle-field; the other a law of peace, work and health, ever evolving new means of delivering man from the scourges which beset him. The one seeks violent conquests; the other the relief of humanity. The latter places one human life above any victory; while the former would sacrifice hundreds and thousands of lives to the ambition of one. . . . Which of these two laws will ultimately prevail God alone knows.

The whole civilized world observes with delight that the profession of medicine, including surgery and the profession of public health and sanitation, stands out distinctly among all the intellectual callings as being steadily and universally devoted to curing the sanguinary ills of war, alleviating human sufferings from disease and folly, and extending for mankind the domain of health and happy life. These professions employ all the resources of physics, chemistry and biology for merciful ends both in peace and in war. The martial professions, on the other hand, employ many scientific discoveries and inventions, originally made for peaceful uses, as means of destruction and death. Biological science has great advantage in this respect over physical and chemical. It can not so frequently or easily be applied to evil ends.

The development of public sanitation practise during the past fifty years has taught democratic communities important lessons on the just subordination of individual interests or rights to collective interests or rights, whenever the fulfilment of individual desires imperils the collective

security. Sanitary regulations often interfere with family management, the schooling of children, the transportation and selling of perishable goods, the established practises of mining and manufacturing corporations and of small tradesmen, and even the personal habits of the private citizen. These interferences are sometimes abrupt and arbitrary. On the whole, however, this teaching has been wholesome in the freedom-loving nations, in which individualism is apt to be exaggerated, and the sense of neighborliness and social unity needs to be quickened.

The rapid development of public sanitation has also given important lessons on promptly utilizing so much as we know of applied science, but also modifying our practises rapidly whenever the subsidiary sciences effect an advance. Forty years ago the filth and fomites theory was the basis of sanitary practise. Municipal and household cleanliness are still inculcated, but the emphasis on them is no longer exclusive. Then, bacteria and other disease-producing organisms became the chief objects of interest for sanitarians, and sanitary practise was based on knowledge of these organisms, and study of the media through which they reached man, such as the air, water, the soil, dust, milk and other uncooked foods. Isolation of all cases of contagious disease was much insisted on. Isolation is still useful in many cases; but it is not regarded to-day as the one effectual defense against epidemics and the diffusion of disease. Next, insect and vermin carriers were made known, and with them came in quite a new set of sanitary practises—not a replacement but a large addition. Lastly, the contact theory of contagion, with its demonstrations that living bacteria may be carried from one person to another in minute vesicles or droplets thrown off in coughing, sneezing, or any convulsive effort, and borne on the air, has gained general acceptance. At the same time, abundant proof has been given that pathogenic bacteria and protozoa develop in the bodies of many persons without causing any recognizable symptoms. Yet the virulence of the germs these persons carry may be extreme. These recent discoveries have introduced serious difficulties into some departments of sanitary practise. The apparently healthy carrier can not be isolated; for he remains unknown. If at any time such carriers and missed cases are numerous in a given community, isolation becomes useless, if not impossible. That is the ordinary condition of most American communities in regard to tuberculosis. Hence, bacteriologists have before them a very useful piece of work in the study of human carriers of disease who are not sick. Meantime sanitary practise is obtaining sound explanations of the occasional failure of its former methods of resisting epidemics, and preventing the spread of the ordinary contagious diseases.

The principal lesson to be drawn from the experiences of sanitarians during the past fifty years is that practitioners of any useful art must be prompt at every stage of progress to make use of knowledge just attained, even if it be empirical and incomplete, and must not linger content or satisfied at any stage. This lesson is applicable in every modern industry and educational or governmental agency during either peace or war.

Biologists are now realizing that biochemistry must furnish the fundamental knowledge of the processes which incessantly go on in the healthy body, and must also provide the exact knowledge of those changes in the normal processes which lead to disease and death. The physician and the sanitarian have become accustomed to

the beneficial use of remedies and defenses which chemistry at present can neither analyze nor synthesize, such, for example, as diphtheria antitoxin; but they are aware that this condition of their art is unsatisfactory and ought not to be permanent. The animal body consists of well-known chemical substances, and its functions depend on chemical reactions. Digestion is largely a chemical process. The animal body consists of innumerable cells in great variety, each of which acts under chemical and physical laws. Hence the belief of the biologist of to-day that chemistry—analytical, structural and physical—can and will come to the aid of the science and art of medicine in the large sense, and will ultimately enable biological science to comprehend the vital processes in health and disease, and to penetrate what are now the secrets of life and death.

CHARLES W. ELIOT

THE BUREAU OF FISHERIES

THE annual report of the Commissioner of Fisheries shows that the bureau has just completed the most successful of the forty-five years of its existence. The number of fish produced and distributed was greater, and the cost of production per million less, than in any previous year. Fifty permanent hatcheries and seventy-six sub-hatcheries, auxiliaries, and egg-collecting stations have been conducted and the output during the fiscal year 1915 was over four billion young fish and eggs, an increase of more than 241,000,000 over the previous year. Plants of food fishes were made in every state and territory; fish eggs were distributed to the fish commissions of twenty-seven states; and consignments of eggs were sent to Porto Rico, Cuba, India, and Japan. The distribution of the output required over 146,000 miles of travel by the five special cars of the bureau and 491,000 miles by detached messengers. The introduction of the hump-back salmon of the Pacific coast into Maine streams, which last year was an experiment, is now a reality, as many of these fish were taken during the summer of 1915 in the Maine rivers; furthermore, ripe eggs have been taken from them—a proof of thorough acclimatization. The counter-experiment of transplanting the Atlantic lobster in Pacific waters is still in progress.

The Bureau of Fisheries has done and is doing much for the conservation and utilization of food fishes which have heretofore been wasted. Each year when the Mississippi and Illinois Rivers, with their various tributaries, overflow their banks and later recede, millions of young fish are left stranded in temporary pools or where in a short time they would perish. Rescue work is, however, undertaken by the bureau, and in 1915 over eight million valuable food fish were saved and delivered to applicants, deposited in public waters, or returned to the main rivers.

The Alaskan seals are the most valuable herd of wild animals ever owned by any government, and the Bureau of Fisheries is their custodian. The revenue to the government from the seal skins—when commercial killing is resumed—will be very large, and efforts are being made to find uses for the seal carcasses, aside from the comparatively small number required by the natives for food. The old practise of using only the skin and wasting the carcass can no longer be countenanced. The report of the special investigators who went to the Pribilof Islands in 1914 to make a thorough study of the conditions of the seal herd was submitted in January, 1915, and presents in detail a statement not alone of the condition of the seal herd, but also of the fox and reindeer herds belonging to the government, and of the natives who inhabit the seal islands. A new method of obtaining supplies for the Pribilof Islands was instituted in 1914–15, and a large saving will result therefrom.

APPOINTMENTS AND DISMISSALS AT THE UNIVERSITY OF PENNSYLVANIA

As a result of the case of Professor Scott Nearing at the University of Pennsylvania, professors of the university appointed a com-

mittee to enquire into tenure of office there and elsewhere, and, as a result of their report, the trustees have passed amendments to the statutes, according to which as a rule professors shall only be promoted or appointed in consultation with the departments concerned. It is provided that there shall be four grades in the faculty: professor, assistant professor instructor and assistant. Professors are to be appointed for an indefinite term; assistant professors will receive a first appointment for three years and re-appointments for terms of five years; instructors and assistants will be appointed for one year. The section dealing with the removal of a professor or assistant professor follows:

A professor or an assistant professor shall be removed by the board of trustees only after a conference between a committee, consisting of one representative from each of the faculties in the university (such representatives being chosen by the faculty of which the representative is a member) and a committee of equal number from the board of trustees, at which conference the provost shall preside, and upon a report from such conference to the board of trustees for consideration and action by them.

THE PAN-AMERICAN SCIENTIFIC CONGRESS

As part of the second Pan-American Scientific Congress a number of receptions have been arranged, including the following:

December 30. 4:30 to 7 P.M. Reception by the president of the congress, the Ambassador of Chile, Senor Don Eduardo Suarez Mujica, at the Chilean Embassy, 1013 Sixteenth St.

December 30. 9 P.M. Reception tendered by the secretary and board of regents of the Smithsonian Institution to the members of the congress.

December 31. 8:30 P.M. Theater party by the Secretary of State and United States delegation to the Latin-American delegations at the New National Theater. Other members of the congress are requested to make their reservations at once with the management of the theater.

January 1. 9 P.M. Reception by the Governing Board of the Pan-American Union to members of the congress at the Pan-American Union.

January 3. 8 to 6 P.M. Reception tendered to the members of the congress by the president and officers of the Cosmos Club.

January 3. 8 P.M. The members of the Second Pan-American Scientific Congress will be the guests of the American Association for the Advancement of Science on the occasion of a special meeting to be held in Memorial Continental Hall.

January 4. 9 P.M. The trustees of the Carnegie Institution of Washington (16th and P Sts.) will tender a reception to the members of the congress.

January 7. Friday night the President will give a reception to members of the congress at the White House.

January 8. Saturday night (hour to be announced). The Secretary of State and the United States delegation will give a banquet to the members of the congress at the Pan-American Union.

SCIENTIFIC NOTES AND NEWS

THERE is published in this issue of SCIENCE the address given at Columbus by Dr. Charles W. Eliot, the retiring president of the American Association for the Advancement of Science. We hope to publish in subsequent issues other addresses given before the association and the other scientific societies meeting during convocation week, together with accounts of their proceedings.

PROFESSOR M. I. PUPIN, of Columbia University, has been elected president of the New York Academy of Sciences.

DR. W. P. HAY, of the U. S. National Museum, was elected president of the Biological Society of Washington at the annual meeting held in December.

DR. FRITZ HABER, director of the Kaiser Wilhelm Institute for Physiology, and Dr. Karl Bosch, of the Baden Anilin Factory, have received honorary doctorates from the Karlsruhe Technical School.

DR. LUDWIG RADLKOFER, professor of botany at Munich, who is now in his eighty-sixth year, has celebrated the sixtieth anniversary of his doctorate.

DR. PAUL BARTSCH and Dr. J. N. Rose have been selected as delegate and alternate to represent the Biological Society of Washington at the Pan-American Scientific Congress.

ACCORDING to the *Bulletin* of the American Geographical Society a letter received from

Carl Lumholtz, dated Batavia, Java, August 6, 1915, said that his plans for leaving Borneo with a party, about the middle of 1914, for exploration in Dutch New Guinea along the Digul River and among the interior islands had been defeated on account of the war. He was about ready to start when the governor-general informed him that he could not fulfill his promise to provide facilities until after the war. The explorer then visited India, where he spent seven months, chiefly at Benares. When he wrote, he was preparing for an expedition to central Borneo, the government supplying him with a photographer, two men to collect the zoological specimens and a small escort of soldiers. His destination was the mountainous region between the two northwestern tributaries of the Barito River, which empties into the Java Sea at the city of Banjermasin. He expected to start on August 14 and to return to Batavia in February or March next, when he hopes to be able to set out on his New Guinea explorations.

President Charles W. Dabney, of the University of Cincinnati, spoke last week before the Cincinnati section of the American Chemical Society, on "Reminiscences of Cincinnati Chemists." This meeting of two days celebrated the twenty-fifth anniversary of the founding of the section.

"The Scientific Work Developed by Dr. Nef" is the title of an address made in Chicago by Professor Lauder W. Jones of the University of Cincinnati on December 17, before the Chicago section of the American Chemical Society. The meeting was a memorial in honor of the late Professor J. W. Neff of the University of Chicago. Dr. Jones was a student and later a colleague of Dr. Nef in the University of Chicago.

On the initiative of the American Institution of Mining Engineers and the American Mining Congress, there will be held in Washington on January 15, a meeting of delegates from a number of scientific societies to arrange plans for a memorial to Dr. Joseph A. Holmes with a special view to favoring the ideals that he advanced for the increased safety of the mining and metallurgical workers and for the conservation of the mineral and natural resources of the United States.

Dr. Rudolph A. Witthaus, known for his work in chemistry and toxicology, who died on December 19, leaves most of his estate of more than $150,000 to the New York Academy of Medicine. Dr. Witthaus left to the Academy of Medicine all his books and the estate for the benefit of the library.

Professor Arthur Williams Wright, professor of experimental physics at Yale from 1872 until his retirement as professor emeritus in 1906, died on December 19 at his home in New Haven, in his eightieth year.

Sir Henry Enfield Roscoe, the distinguished chemist, emeritus professor in the University of Manchester, has died at his home in Surrey, aged eighty-two years.

A press despatch from Albany says that Governor Whitman has endorsed the work of Dr. Hermann M. Biggs, head of the State Department of Health, by approving practically all the requests for health extension work laid out for the coming fiscal year. Dr. Biggs has submitted requests for appropriations amounting to $626,525, as against $380,775 expended this year. The increased expenditures provided are largely for the departmental laboratories and for expert service.

According to a telegram from Chicago to the daily papers, the Illinois supreme court has upheld the decision of the appellate court and ordered the removal of the present board of directors of the American Medical Association. The decision is rendered in the suit filed five years ago by Dr. G. Frank Lydston, of Chicago, who claimed the affairs of the association were controlled by an oligarchy. He attempted to prevent Dr. George H. Simmons, of Chicago, then secretary of the association, from holding three offices at once. Under the ruling of the court, members of the present board of directors were elected illegally, inasmuch as the association was incorporated under a charter from Illinois and therefore must hold its meetings in that state.

DR. E. T. CRANE, editor of *Chemical Abstracts*, writes to members of the American Chemical Society that *Chemical Abstracts* has reached a critical stage in its development, a collective index being needed. The foreign chemical abstract journals publish either five-year or ten-year indexes. The adoption of a similar policy by *Chemical Abstracts* is essential if its value as a permanent record is not to be gradually lost. The completion of the tenth volume is the logical occasion for the appearance of the first collective index. Since the resources of the society are not sufficient to meet the needs of this expensive undertaking, it is necessary that at least a large part of the cost be guaranteed by advance subscriptions.

THE publication is announced of a quarterly *Journal of Cancer Research*, the official organ of the American Association for Cancer Research, to be edited by Richard Weil, Cornell University Medical School. The other members of the editorial committee are: Joseph C. Bloodgood, The Johns Hopkins University; Leo Loeb, Washington University; Ernest E. Tyzzer, Harvard University; H. Gideon Wells, University of Chicago, and William H. Woglom, Columbia University.

UNIVERSITY AND EDUCATIONAL NEWS

IT is now said that the estate left by Amos R. Eno is likely to amount to $15,000,000. Provided the will filed for probate on October 28 stands, in the face of the contest being made by Mr. Eno's next of kin, Columbia University's share of the estate will be about $7,000,000.

GRINNELL COLLEGE has received $50,000 from an anonymous donor in the east. The college is conducting a campaign for new endowment and buildings. Recently a parcel of land in Kansas City, valued at $150,000, was turned over to the college for the purpose of financing the start of a new men's dormitory system. The alumni of the college are raising funds for a new recitation building, the construction of which will be commenced next spring, which will cost in the neighborhood of $250,000.

A 550-TON locomotive has been presented by the Illinois Central Railroad Company to the University of Illinois. The university will use its new possession for instructional purposes and also for research work in its locomotive testing laboratory.

THE staff of the departments of physiology and biochemistry of the Fordham University School of Medicine has been reorganized and is now made up as follows: Lewis William Fetzer, Ph.D., M.S., professor of physiology and biochemistry; George F. Sheedy, Ph.B., M.S., assistant professor of physiology; Carl P. Sherwin, M.S., Ph.S., assistant professor of biochemistry; John Allen Killian, A.B., A.M., instructor in physiology and biochemistry.

AT a recent meeting the trustees of the University of Illinois promoted Dr. Trygve D. Yensen, in recognition of his work on the magnetic properties of iron and iron alloys.

DISCUSSION AND CORRESPONDENCE

A GALAPAGOS TORTOISE

A FEW facts of interest in regard to the Galapagos tortoise *Testudo vicina* Gunther, are hereby submitted as they have a bearing on the growth of a family which heretofore was believed to progress very slowly.

On April 20, 1914, we received by express from Riverside, Cal., a dead tortoise weighing 450 pounds. This specimen was brought from the Galapagos Islands in 1900 by Edmund Heller, who later accompanied Colonel Roosevelt on his African trip, and weighed at time of its capture in 1899 only 29 pounds.

It was taken to the home ranch at Riverside, Cal., where it died April 18, 1914.

Its death was reported to Edmund Heller, at Washington, who immediately donated it to the Museum of History, Science and Art, Exposition Park, Los Angeles, Cal.

The specimen itself was not only mounted but the entire skeleton was installed as a separate exhibit, the two forming a striking addition to the science wing of the museum.

The following extracts from Edmund Heller's letter in regard to the tortoise are of especial interest:

It is a real pleasure to learn from you that the Galapagos tortoise which you have recently re-

ceived from my brother at Riverside has met with so much appreciation at the Museum of History, Science and Art. The tortoise was a particular pet of mine, although a very stupid one. At Riverside during his residence of fourteen years he entertained a large number of visitors annually and was locally well known. I anticipated a very long life for the tortoise, at least a century, and his untimely death has been a great disappointment. The following data concerning the specimen will doubtless be of interest to you.

I found him in June, 1899, at Iguana Cove, Albemarle Island, Galapagos Islands. At the time of his capture he weighed 29 pounds, and was, I presume, not much over a year old. He was carried on the schooner, where he lived on the deck with several adult tortoises and fed on *Opuntia* cactus until we reached San Pedro Harbor. At Riverside he grew at a rapid pace during the first few years and doubled his weight annually—at the time of his death I should judge he was not over sixteen or seventeen years of age.

Mr. Ditmars, of the reptile department of the New York Zoological Park, states that several of his giant tortoises have died of inflammation of the kidneys, due to resting on damp soil, and this may doubtless explain the death of my specimen at Riverside.

You will find this tortoise referred to in a paper on "The Reptiles of the Galapagos Islands" by me published in the *Proceedings of the Washington Academy of Sciences*, February, 1903, Vol. 5, page 52.

There is no record of its size at time of capture, except as to weight, which was 29 pounds. At the time of its death it weighed 450 pounds and its carcass measured 41 inches long, 31 wide and 21 high. Mr. William Heller, who had personal care of the tortoise for many years, writes me that it thrived wonderfully on a diet of spineless cactus, milkweed, melons, oranges, etc.

Frank S. Daggett
Museum of History, Science and Art,
Los Angeles, Calif.

TWO PARTIAL-ALBINO BIRDS

On the first three days in October, in and near Webster Park, Orono, Me., there was observed a partial-albino robin (*Merula migratoria*). I examined it carefully with a field-glass. The white feathers are remiges, forming a white patch in each wing when the bird is standing. When the bird flies the fluttering white wing feathers give it a striking and beautiful appearance which must attract the attention even of the layman. In the left wing the white quills include all the longest primaries and extend far enough I think to number 12 or 13 all told. Among the lesser coverts of the left wing appear also two white spots, each apparently formed by the tip of a single feather. In the right wing the position of the white quills is different: the longest primaries (5 of them, I judge) appear perfectly normal; these are followed by about 7 white remiges. So far as I could see, the bird is in all other respects quite normal. The white terminal spots on the outer tail feathers are conspicuous, but not abnormally so. The white of the belly does not extend so far forward as I have seen it on some normal specimens. The white markings on the head, and the very narrow edgings of the breast feathers are as usual. The red of the breast is, I judge, both brighter and darker than the average. The bird is tame, frequents door-yards, and ought to be seen by other observers on its migration. To shoot such a bird and set up its skin in a museum is a wanton destruction of scientific material; if taken at all it should be taken alive and used for breeding.

On October 3, in Old Town, Me., I saw a partial-albino house sparrow (*Passer domesticus*), the white being in great masses on the wings, so that in flight this individual looks somewhat like a snowflake. In many years of bird observation I never saw another house sparrow with such an extensive albinism as this one.

Wallace Craig
University of Maine

ANOPHELES PSEUDOPUNCTIPENNIS

In the article entitled "The Rôle of *Anopheles punctipennis* Say in the Transmission of Malaria," which appeared in the issue of Science for December 17, 1915, an unfortunate error occurs. In discussing the work of Dupree and Knab's comments thereon it was stated that the latter was inclined to believe that the experiments had been conducted with

A. punctipennis. This term should have been *A. pseudopunctipennis,* which in fact is a species quite distinct from the *punctipennis* with which Dr. Dupree worked. W. V. KING

SCIENTIFIC BOOKS

Scientific and Applied Pharmacognosy intended for the Use of Students in Pharmacy, as a Handbook for Pharmacists and as a Reference Book for Food and Drug Analysts and Pharmacologists. By HENRY KRAEMER, professor of botany and pharmocognosy in the Philadelphia College of Pharmacy. One vol., pp. viii, 857, with over 300 plates comprising about 1,000 figures. Published by the author, 145 North 10th St., Philadelphia.

The writer well remembers the "Manual of Materia Medica" which was used at the Philadelphia College of Pharmacy as text in the middle of the eighties. Its author had gone beyond the mere description of the gross characteristics of the crude drugs and, following German example, had added *Lupenbilder* to his text. For the rest, it was a compilation of names and synonyms of plants, of constituents and properties, with a purely technical description of the part used as drug. It contained the bare facts which the student was expected to commit to memory. For review purposes, the student fell back on a booklet composed of synoptical tables. In justice to Professor Maisch it should be said that his personality and even his lectures were much more interesting than his text. Indeed, to the student who attended college with a real desire to improve himself, Professor Maisch was one of the principal incentives to aspire to higher ideals.

With even more vividness, the writer remembers a meeting of the Scientific Section of the American Pharmaceutical Association at which the author of the treatise under review read a paper on the teaching of pharmacognosy. Always sincere in what he presents and full of enthusiasm of his mission, the speaker carried away his audience, which apparently felt that a new day had dawned in pharmaceutical pedagogy.

If Bastin had already gone a step farther than Maisch, his successor seemed to feel that pharmacognosy was to be made an exact science by the histological study of drugs. His ambition was to drill his students so that, even in their dreams, they might recognize the fragments of tissues found in a mixed powder of several drugs and thereby identify the components. This was a highly ambitious program, the attainment of which might be realized by a few experts who had spent their lives in work of this kind, but was scarcely to be hoped for on part of the undergraduates. Moreover, such a course, even without the possible hope of attainment, is just as highly technical as the text of Maisch's "Manual." Neither should be the goal of the teacher of pharmacognosy. Fortunately for the teaching of pharmacognosy in the United States, Professor Kraemer, not many years later, repudiated his own position and came out boldly for the mastering of a few fundamental principles as opposed to the grind of a lot of technical detail.

The statutory definition of pharmacy and pharmacology by the department of education of the state of New York is exceedingly unfortunate and reveals, as well as any single incident may, the arbitrariness of educational standardization. It was not to be expected that a representative of the P. C. P. would be unduly influenced by legislation at Albany, yet we are grateful for the use of the word pharmacognosy rather than pharmacology as the characteristic word in the title. Both words mean etymologically the same, both stand for what may be regarded the same science, yet, whereas pharmacology represents the medical viewpoint, pharmacognosy represents that of the pharmacist. Both pharmacologist and pharmacognocist deal practically with the same subject-matter, but the point of emphasis of each naturally differs according to his professional viewpoint. The student of pharmacology wants to know about the vegetable origin of his drugs, he must know something about their chemical constituents, but the point of emphasis is that of physiological action. Wherever possible, it is the animal experiment that engages his attention as pro-

spective physician. As prospective pharmacist, the student of pharmacognosy wants to know that cinchona is a febrifuge, but he should know primarily what alkaloids are contained in cinchona bark and should have experience in the chemical assay for total alkaloids as well as for quinine. He should be posted on the botanical characteristics, both macroscopic and microscopic, of the drug and learn how to make the medicinal preparations and the reasons for a given method of preparation. Thus the students of medicine and pharmacy, in studying the same subject-matter, should have their subject presented from supplementary, not identical, viewpoints, so that later, as medical and pharmaceutical practitioners, their combined knowledge and experience may prove to the greater advantage of suffering mankind.

Both classes of students, however, should get something more than mere technical information out of these two courses. The mental discipline that should come from all scientific study should not be denied them. Moreover, the humanizing aspect should receive due attention. This is particularly true of the study of pharmacognosy. Possibly no science touches mankind at more points than does pharmacognosy. From the crude drug bale, with its interesting commercial history and even romance, to the working out of the structure of its physiologically active organic constituent and its administration, so many phases of human activity are involved that pharmacognosy may be regarded as one of the best examples of what may possibly be designated the modern scientific humanities.

In his Phi Beta Kappa address at Johns Hopkins the editor of SCIENCE made the following statement:

> That education is liberal which enlarges the sympathies and emphasizes our common interests, not that which forms an exclusive clique. On the whole the sciences in their application to human life seem more likely to form an adequate basis for a common culture than the dead languages.

This is certainly true of pharmacognosy. Teachers of history have gone beyond the mere history of wars and warring dynasties, they have even gone beyond the history of institutions and are touching upon certain phases of art as expressions of the evolution of man, but possibly not one has realized that the revolution in chemistry, brought about by Lavoisier, was possibly as important to mankind as the French political revolution, as a victim of which the great scientist was guillotined. Flueckiger was possibly the first to emphasize the humanizing aspects of pharmacognosy. In his "Handbuch der Pharmacognosie," Tschirch carried out the ideas of his master in word and picture, as might be expected of an artist of the camera as well as of the pen.

Compared with the masterpiece of the enthusiast in Bern, Henry Kraemer's "Scientific and Applied Pharmacognosy" falls short to such an extent that the two are not to be regarded in the same class either as to scope or as to execution. One grave mistake, however, which Tschirch made, Kraemer has avoided. Though Tschirch had been teaching pharmacognosy for a life time from the point of view of the botanist, when it came to the publication of his manuscript he adopted a chemical basis of classification of the material. Thus the attempt to place his work on what he apparently regarded a more scientific basis resulted in pseudo-science. Kraemer more fortunately arranges his material according to families.

A detailed criticism of a work like this does not seem called for in a journal like SCIENCE. Errors of statement can, no doubt, be found by any specialist who looks for them in his particular field. If the reader of this review will take the trouble to compare the text- and handbook under consideration with Tschirch's "Handbuch," still in the process of appearing in *Lieferungen,* he need not be told why the German masterpiece would not do as a textbook; nor need the inferiority in text, illustration and general make-up of the new American text be pointed out. One point, however, is noteworthy as a curious omission. Among the works consulted, the author in his preface does not even mention Tschirch, or his predecessors Flueckiger and Hanbury. While, so far as illustrations are concerned, the author has apparently endeavored to impart to his treatise

what may be regarded as a laudable American aspect, it can scarcely be thought possible that he has not consulted, and consulted freely, every fascicle of Tschirch's "Handbuch" as it has been issued from the press. Though the present unfortunate war is teaching us how derelict we have been in making ourselves independent of Europe, so far as vegetable drugs are concerned, yet the pharmacognocist, above all, should ever be mindful of the inscription on the Flueckiger medal: *Scientia non unius populi sed orbis terrarum.* E. K.

Practical Oil Geology. By DORSEY HAGER. McGraw-Hill, New York, 1915. Pp. xii + 141; figs. 76, three being full page, and one plate. $2.00 net.

This handy pocket book puts the stock-in-trade of the petroleum geologist and engineer before the petroleum investor in a way that invites friendship. Further, it lays sound ideas of applied structural and stratigraphical geology before a class which is glad to substitute such revelations for the "luck" of the oil (or water) wizard.

While the space is so small as to call for brevity at the expense at times of clearness, the numerous excellent cuts—most of them evidently the author's—more than balance in field ingenuity and the applications of pure geology what may be wanting in the way of academic clarity of statement.

Only two or three proof errors appear in the text proper. An early second edition for so good a book on a timely subject seems sure, and in the reappearance no doubt there will be weeded out such oversights as: "Igneous rocks, or volcanics," p. 28; "a level line in the plane of the horizontal," p. 71; "curved axis," fig. 50 and p. 86; Comanchean equivalent to the whole Mesozoic, p. 88. Certainly the errors in Table XI. will not be recopied, nor perhaps that in averaging the viscosity of Oklahoma oils, especially the unfair inclusion of the high viscosity from Wheeler, Table VI. Convenience would be served by referring to a figure on a definite page rather than, say, "(See Fig. 19, Chapter III.)."

Useful adaptations for the layman are: Geological Names (Kemp); Mathematical Tables (Hayes); Tests for Oil (Woodruff); Favorable and Unfavorable Indications for Oil (Craig); Definitions of Formation and Member (Snyder). Other tables and data will serve more technical needs, and the cuts will doubtless be freely drawn upon by other authors.

The neat and convenient get-up, and strong, leather binding are characteristic of these publishers. CHARLES T. KIRK

STATE UNIVERSITY,
ALBUQUERQUE, NEW MEXICO

SPECIAL ARTICLES

ON THE RELATIVE NUMBERS OF RHIZOPODS AND FLAGELLATES IN THE FAUNA OF SOILS

THE investigations upon the protozoan fauna of the soil and its interrelations with the bacterial flora therein contained has opened a new field of exploration and suggested a new line of attack for the problem of "sick soils." The work of Russell and Hutchinson and their school indicates that the constituents of the protozoan fauna, notably the amœbas, affect appreciably the bacterial content of the soils they inhabit, and thus impinge upon some of the problems of fertility. This line of evidence has stimulated many preliminary investigations into the extent, distribution and qualitative make-up of the protozoan fauna of the soil. In many cases these attempts at the qualitative determination of these organisms have gone no farther than to record the relative numbers of the individuals belonging to the groups of rhizopods, flagellates and ciliates, with occasional questionable identifications of a few genera or more rarely still of species. The purely preliminary status of such investigations is readily inferred by those familiar with the fields of bacteriology, immunity and protozoology. Valid conclusions here can rest only upon a knowledge of the fauna which extends to an accurate determination of the species concerned and of their feeding habits or symbiotic relationships to the bacterial flora, which may be even more subtle than the gross phase of food relations.

One naturally recalls in this connection the

similarities of *Entamœba coli* Lösch and *E. dysenteriæ* Councilman and Lafleur, and their long-standing confusion in the biological and medical literature, notwithstanding the very profound differences between them in their relations to their human host, the one a harm-

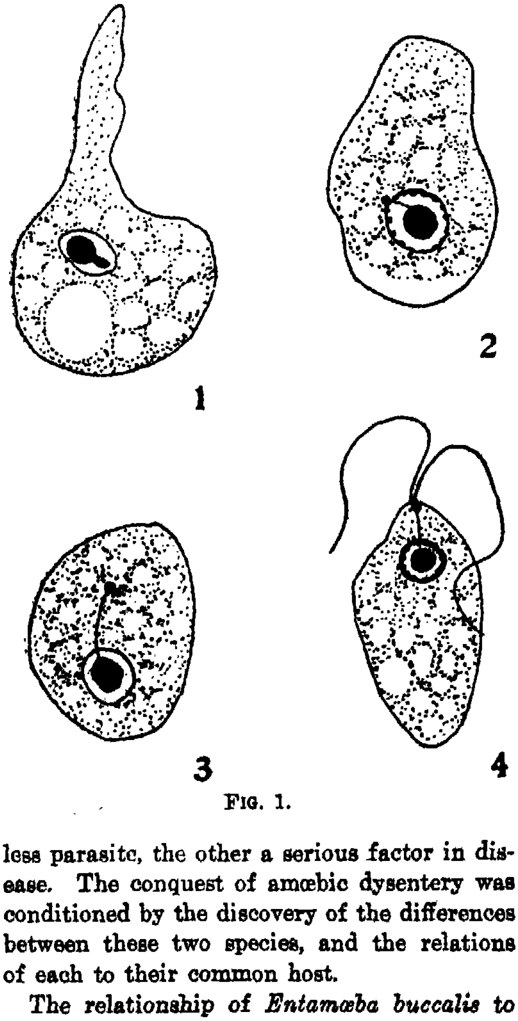


Fig. 1.

less parasite, the other a serious factor in disease. The conquest of amœbic dysentery was conditioned by the discovery of the differences between these two species, and the relations of each to their common host.

The relationship of *Entamœba buccalis* to Riggs' disease, or pyorrhea, is not only a problem in parasitism, but probably one also of the commensal relationship of this amœba and the bacterial flora of the gingival abscesses.

The remarkable and unique protozoan fauna of the first and second stomachs of the ox and other ruminants is composed of not less than 6 genera and 24 species living together in closest proximity in a common medium, but their relationships to it are not uniform. One species of the genus, *Diplodinium ecaudatum,* is, for example, exclusively a bacterial feeder (see Sharp, 1914), while others in the same genus feed indiscriminately on other components of stomach contents.

Indeed it is not impossible that, as in the case of pathogenic protozoa and bacteria, there will be found to be strains or pure lines within the species, whose ecological relationships may be so different among themselves as to lead to divergent conclusions regarding the species.

These facts lead to the inference that the mass treatment of the protozoan fauna of the soil without regard to its component species will tend to obscure and confuse its relationship to the bacterial and other flora, to the chemical conditions related thereto, and to the problem of sick soils and of fertility.

In a recent survey of the literature on the protozoa of the soil I have been struck by the great divergence of results at the hands of different investigators as to the nature and extent of the protozoan fauna discovered by direct examination and by culture methods. To the student of the ecology of the protozoa this divergence is to be expected in view of what is known of the seasonal fluctuations in numbers and kinds of protozoa in the population of reservoirs, ponds, lakes and streams. Adjacent bodies of water may have a very different seasonal history in these respects as I have shown (1904, 1908) with regard to the plankton of the Illinois River. Furthermore these minute organisms are very susceptible to infinitesimally small doses of certain mineral salts, notably copper sulphate. A treatment of a reservoir with this salt to the amount of only one part to ten million by weight will completely kill out most flagellates having chlorophyll in any of its forms in their organization and result in a total reorganization of the microfauna and microflora of the body of water thus treated, which persists for several months at least. Add to the seasonal fluctuations in heat and moisture and the local differences in chemical composition, the access of adventitious substances in rainfall, tillage, fertilizers, flood waters and seepage, and it is

not strange that the protozoan fauna lacks uniformity. The chemical decompositions in the soil itself, its gaseous content, the antagonisms of certain salts, the demands upon the soil by its superterranean flora, the fluctuating bacteria and molds, the ravages of nematodes and the toxin and excreta of all of the organisms living therein and thereon, all form a part of the agencies potent in modifying, stimulating or depressing the protozoan fauna as a whole, and its several elements differentially.

One of the principal points brought out by recent investigations has been the relative numbers of flagellates and amœbas, the main interest centering in the latter because of their possible action as bacterophages of bacteria active in fixation of atmospheric nitrogen. The late C. H. Martin, whose death at the Dardanelles is an irreparable loss to the science of protozoology, has shown (1912) that one flagellate, *Monas termo* Ehrbg., is associated with the occurrence of certain "sick soils" in Great Britain, but little precise work has been done as yet elsewhere upon the flagellates of the soil.

Two papers published recently are typical of the divergences of results with respect to the relative abundance of amœbas and flagellates in the normal fauna of soils. Cauda and Sangiorgi (1914) in soils from rice localities find that amœbas are the prevailing forms, were present in all localities, and were exceeded in numbers by the flagellates in one case only. Flagellates together with the ciliates were sometimes entirely absent. On the other hand, Sherman (1914) concludes that the active protozoan inhabitants of most soils are probably restricted to the flagellates, that they constitute the greater portion of the protozoan fauna of the soil, and that the amœbas do not ordinarily occur in numbers nearly as great as do the flagellates. Both of these conclusions may well be correct *for the soils examined*, but I wish to cite facts which necessitate caution in making sweeping conclusions from such data and to set forth a new factor not as yet considered, in so far as I can infer from the literature, by any investigator of soil protozoa. The absence of its consideration tends to weaken or possibly even to vitiate conclusions as to relative numbers of amœbas and flagellates.

Certain investigations carried on in my laboratory by Dr. Charlie W. Wilson (1915) on the life history of a soil amœba have a direct and, it seems, an important bearing on this problem of the seeming relative numbers of amœbas and flagellates. I use the term "seeming" advisedly for the investigations prove that the common soil amœba, *Nægleria gruberi* (Schardinger), has a biflagellate phase, and enflagellates and exflagellates rather quickly on slight provocation under the conditions of laboratory culture. Not only do single individuals undergo these transformations but the whole mass of the culture may do so. The bearing of this fact upon the reported difference in the flagellate and rhizopod components of the protozoan fauna of the soil is self-evident.

This amœba (Fig. 1) is a small organism ($8\,\mu$ to $30\,\mu$) with one broad blunt pseudopodium or sometimes several blunt ones, and one subcentral nucleus. When it enflagellates the karyosome sends out a chromatic process (Fig. 2) which traverses the nuclear membrane, forms a marginal blepharoplast, and emerges as two long flagella (Figs. 3, 4). The body assumes a rigid asymmetrically curved shape and the organism swims away in the typical spiral course. When it exflagellates the flagella shorten and thicken and retreat into the cytoplasm and the blepharoplast returns to the karyosome within the nucleus. It takes about 70 minutes for a culture of amœbas to become one of flagellates, while the reverse process is somewhat longer and less uniformly followed by the individuals in the cultures. The addition of water, or fresh culture medium (filtered and sterilized soil and manure infusion) or the access of air, tends to induce enflagellation, but exflagellation is less definite in response to their opposites. Fission, budding, encystment, excystment and chromidial extrusion occur frequently and rather quickly.

These processes and the flagellate stage are evidently adaptive phenomena fitting this organism to a life in the soil with its vicissitudes of fluctuating food supply, alternations

of drouth and moisture, and changing chemical and physical conditions.

This amœba was recovered by Wherry (1913) from the water-supply of the adjacent city of Oakland, California, but it is primarily, in our experience, a soil amœba, found in undisturbed alluvial soil along Strawberry Canon on our campus, in garden soils and appears to have its maximum abundance at a depth of about four inches, though it was also recovered on our campus from clay and rock talus *in situ* in the sides of the excavation for the Sather Campanile to a depth of over twenty feet. It has also been found in cultures from various ranch soils from the central valleys of California.

It is not distinguishable by any morphological characters from a species described by Schardinger (1889) as *Amœba Gruberi* from human feces in a case of dysentery at Vienna, Austria. There is evidence that this author used pure culture methods. It is possible, however, that the cysts might have taken in food or water and have passed intact through the digestive tract and then have been recovered from the feces in the culture, but contamination from dust or water are equally open as possibilities. All of these facts taken together lead to the inference that this amœba, *Nægleri gruberi* (Schardinger), may have a wide distribution in the soil and to be cosmopolitan in its occurrence. If this proves to be the case, or if other amœba of the soil have similar flagellated stages, it is obvious that future investigations of the relative distribution of amœbas and flagellates in the soil should be so conducted as to avoid the complications in interpretation and conclusions involved in the Jekyll-and-Hyde life history of this organism.

Literature Cited

Cauda, A. and Sangiorgi, G.
1914. Untersuchungen über die Mikrofauna der Boden aus Reisgegenden. Centbl. Bakt. 2 Abt., 42, 393–398, 6 figs. in text.

Kofoid, C. A.
1904. The Plankton of the Illinois River. Part I. Bull. Ill. State Lab. Nat Hist., 6, 95–629, pls. 1–50, 2 figs. in text.
1908. Idem. Part II. *Ibid.*, 8, i–viii., 1–361, 5 pls.

Martin, C. H.
1912. A Note on the Protozoa from Sick Soils, with Some Account of the Life-Cycle of a Flagellate Monad. Proc. Roy. Soc. London, B. 85, 393–400, pls. 10.

Schardinger, F.
1899. Entwicklungkreis einer *Amœba lobosa* (*Gymnamœba*): *Amœba Gruberi*. S. B. Akad. Wiss. Wien, Math-natwiss. Cl., 108, 713–734, pls. 1–2.

Sharp, R. G.
1914. *Diplodinium ecaudatum*, with an Account of its Neuromotor Apparatus, Univ. of Calif. Publ. Zool., 13, 43–122, pls. 3–7, 4 figs. in text.

Sherman, J. M.
1914. The Number and Growth of Protozoa in Soil. Centbl. Bakt. 2 Abt., 41, 625–630.

Wherry, W. B.
1913. Studies on the Biology of an Amœba of the *Limax* Group. Arch. Prot., 31, 77–93, pls. 8–9, 8 figs. in text.

Wilson, C. W.
1915. On the Life-history of a Soil Amœba. Univ. Calif. Publ. Zool. (In press.)

Charles A. Kofoid

Zoological Laboratory,
University of California

THE NATIVE HABITAT OF SPONGOSPORA SUBTERRANEA

The discovery of *Spongospora subterranea*, the powdery scab organism, on recent importations of potatoes from Peru by the Department of Agriculture has furnished important evidence bearing on the question of the origin of this parasite. *Spongospora* is widely distributed in Europe and within the last three or four years has established itself in several widely separated localities in the United States and Canada, but the problem of its origin has remained unsolved.

Kunkel's[1] recent work on *Spongospora* has demonstrated that a very intimate relation exists between the host cells and the parasite.

[1] Kunkel, L. O., "A Contribution to the Life History of *Spongospora subterranea*," *Jour. of Agr. Research*, 4: 265–278, Pls. XXXIX.–XLIII., 1915.

The latter does not cause a rapid destruction of host tissue such as is seen in many cases of recently established parasitism, but rather produces a temporary conservation of the host cells followed by their gradual destruction, in short, the type of development to be expected in parasitism of long standing. Hence we may safely conclude that the association of *Spongospora* and the potato is an ancient one, and we should therefore naturally look for the original home of powdery scab in some very early habitat of the potato. In 1891 Lagerheim[3] collected *Spongospora* in Quito, Ecuador, and stated that the disease was well known in that region, but he gave no evidence bearing on the question as to whether it had long existed there or had been recently introduced, possibly from Europe, where it has been known to exist since 1841. Evidence on this question is now at hand.

Mr. O. F. Cook, of the Bureau of Plant Industry, recently returned from South America, bringing specimens of a large number of native varieties of potato from Peru. When these collections were examined by the undersigned pathological inspectors of the Federal Horticultural Board at Washington, about one third of the tubers were found to be affected with powdery scab. Their identification of the organism has been verified by Mr. C. W. Carpenter of the Bureau of Plant Industry. The diseased tubers came from the eastern slope of the Andes, all having been grown at altitudes of 10,000 feet or more in the regions about Cuzco and Ollantaytambo, Peru. Some of the infected tubers were obtained direct from the fields of the Indians near the upper limit of potato cultivation in the Panticalla Pass, between the Urubamba and Lucumayo valleys, at an altitude of over 12,000 feet. Mr. Cook states that potatoes are never imported in these localities, only the original native varieties being grown. Hence introduction of the disease from Europe or any other foreign locality into this region of primitive potato-growing seems most improbable. Both host and parasite are apparently indigenous.

[3] Lagerheim, G. de, "Remarks on the Fungus of a Potato Scab (*Spongospora solani* Brunch)," *Jour. of Mycology*, VII., 103–104, 1892.

Further evidence tending to show that the disease is native to Peru and not introduced is furnished by the character of the disease itself as it develops on the Peruvian potatoes. The sori are in general smaller and shallower than those usually produced on most varieties of European or North American tubers, and show less destruction of host tissue, indicating that the disease is not of a serious nature in Peru. This inference is strengthened by Mr. Cook's statement that the natives are not concerned over the disease, in fact do not consider it an injury. That the fungus is common and generally distributed is proved by the fact that about one third of the tubers collected in this region showed *Spongospora* sori. The slight importance of the disease in Peru as compared with its greater virulence in Europe and North America is easily understood if South America is the native habitat of the parasite. Ancient association of the host and its parasite would naturally have developed a high degree of resistance on the part of the potato and have produced the balanced relation of host and parasite so commonly seen in cases of long-established parasitism.

The evidence indicates, therefore, that South America, which is the native habitat of the potato, is also the home of *Spongospora*. If so, we may add one more organism to the already long list of parasites which are relatively unimportant in their native habitats, but which have developed greater virulence and destructive power when introduced into new regions, especially if in the new localities the host plants have been subjected to more intensive cultivation.

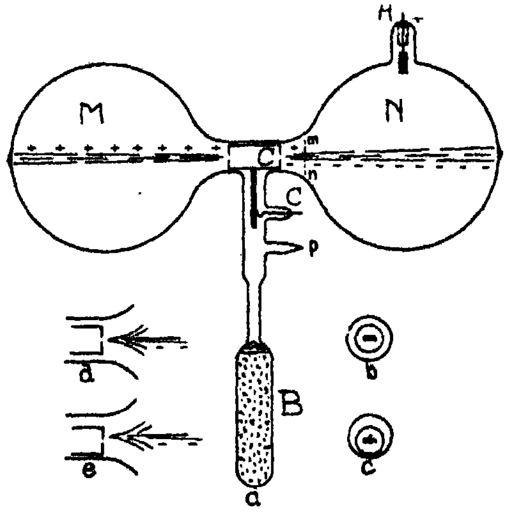
The discovery of powdery scab on these Peruvian potatoes shows the need of very careful inspection of all imported plants and emphasizes the great importance of obtaining healthy material for breeding or other experimental purposes. Such material should be entirely free from disease, even from diseases which are apparently of little importance in the native habitat of the host.

G. R. LYMAN,
J. T. ROGERS
FEDERAL HORTICULTURAL BOARD,
U. S. DEPARTMENT OF AGRICULTURE

COLOR EFFECTS OF POSITIVE AND OF CATHODE RAYS IN RESIDUAL AIR, HYDROGEN, HELIUM, ETC.

As is well known positive rays have their origin in front of the cathode, and under the action of the electric force fall toward it. If the cathode is perforated the rays stream through and constitute the "kanal strahlen" of Goldstein. Tubes built to exhibit this phenomenon form a part of the regular equipment of nearly all collections of apparatus intended to exhibit the phenomena of electric discharge through gases.

Most beautiful and striking color effects may be had by using hollow cathodes[1] in specially designed tubes containing each a trace of some inert gas such as helium, argon or neon. The color effect is striking because the cathode beam is of one color, while the positive ray beam in the same gas is of an entirely different color. The general design of the tubes that Dr. Jakob Kunz and the writer



have found best suited is shown in the accompanying figure. The discharge tube is dumb-bell shaped. It is made of two 2 liter Florence flasks, M and N. The hollow cylindrical cathode C is mounted in the neck, while the anode A is placed in one of the bulbs. The cathode terminal C, the nipple p for exhausting, and the charcoal bulb B are all attached to one vertical tube as shown.

The process of filling the discharge tube, sealing it off from the pump, and its subsequent use is as follows: After the tube is constructed, and the charcoal bulb B attached, the exhaust nipple is put in communication with a pump, and also to some source of the gas to be used. During the early part of the exhaustion it is well to gently heat the bulb B. Continue the pumping until the tube on sparking shows a tendency of becoming hard. As this stage is approached cathode rays will appear as a compact beam in the bulb N, while a beam of positive rays will traverse the bulb M. Now admit a small quantity of the desired gas, say, helium. The chances are that too much gas will enter the discharge tube and thus destroy the definition of the two beams. To restore it pumping should be continued and at the same time the bulb B should be carefully submerged in liquid air. Care must be exercised not to reduce the content of helium by too long continued pumping. The cooled charcoal will absorb the traces of air leaving the tube MN relatively richer and richer in helium—since helium, an inert gas, is but slightly absorbed by the cooled charcoal. The cathode beam in N as well as the positive ray beam in M will each increase in brightness and definition, reaching a maximum, after which, as the process continues, they will begin to fade. At the stage when the beams are judged brightest the exhaust nipple p is sealed off from the pump. The tube is now in its finished state. Removing the liquid air, the charcoal gives up its absorbed gas and the beams weaken and become diffused. For subsequent use it is only necessary to submerge B in liquid air while the discharge from an induction coil is passing. The beams in M and N will increase in brightness and definition as the absorption of the active gases proceeds, thus giving ample time for the observation of the changes going on within the tube.

The most interesting phenomenon is the *color* of the two beams. The cathode beam in helium is a greenish gray color, while the positive ray beam in the *same* gas is a beautiful red. There is no mistaking the colors. Indeed the red due to the positive ions is so persistent that it appears at the very origin of these rays—at the edge of the Crookes dark

[1] J. J. Thomson, "Rays of Positive Electricity," p. 6, 1913.

space in front of the cathode (shown by the dotted line *mn* in the figure).

The usefulness of the above described tube for many laboratories is limited because liquid air is used in its initial adjustment and subsequent operation. If desired the bulb *B* may also be sealed off. The only disadvantage is that this fixes the gas content in the tube. In case no liquid air is available it is still possible to construct the tube provided access may be had to a good pump. In this event the discharge tube should be washed out several times with the desired gas, in order to remove every trace of air, and then sealed off when the beams are brightest. This gives a permanent tube provided the occluded gases in the electrodes and walls of the vessel do not in time let the vacuum down. Danger from this source, however, may be largely avoided by gently heating the tube during exhaustion. The obvious advantage of a charcoal bulb is that the proper exhaustion can always be reached and at the same time the discharge at various stages of exhaustion successively exhibited.

It should be added that the best results only are obtained when the hollow cathode *C*, which is an aluminum cylinder closed at the ends with aluminum discs through the center of each is cut a rectangular opening about 1 mm. by 6 mm., is placed exactly on the axis of the tube connecting the bulbs *M* and *N*. The correct position is shown in the figure, end view at *b*, and side view at *d*. The discharge leaving the cathode, confined in a narrow tube as here, is always along the axis of the glass tube, regardless of the alignment of the cathode. In other words, the shape of the glass tube rather than the shape of the cathode determines the position of the cathode beam. Lack of alignment is shown at *c* and *e* where the opening through the hollow cathode is below the axis and as a result few positive rays get through and show in the bulb *M*, though they show distinctly at their origin in front of the cathode. To avoid possible lack of alignment it is advised to make the hollow cathode *C* of such diameter so as to fit snugly into the neck connecting *M* and *N* as shown in *a* of the figure.

An interesting test to show that the beam in *N* is composed of electrons, and that in *M* of positively charged ions, is to deflect them in turn by a strong electro-magnet. The cathode beam is readily deflected while the positive ray beam is but little deflected and that in the opposite sense. This is in full agreement with the theory of the magnetic deflection of moving positive and negative charges.

Chas. T. Knipp

Laboratory of Physics,
University of Illinois,
October 9, 1915

THE AMERICAN CHEMICAL SOCIETY

The fifty-first meeting of the American Chemical Society was held in Seattle, Washington, August 30 to September 3, 1915, inclusive. The members came to Seattle from many directions, although a special car brought thirty-three over the Great Northern railroad on the evening of the thirtieth. Those who came in the special car spent August 29 in Glacier National Park. The meeting was opened by an address of welcome by the dean of the University of Washington, to which response was made by President Herty. A general meeting was then called to order and listened to an address by Leo H. Baekeland on "Chemical Industry" and a second address by H. K. Benson on "Industrial Resources and Opportunities of the Pacific Northwest." Following these addresses the society continued in general session until noon of the following day, holding public symposiums.

On Wednesday afternoon the various additional programs were held as well as the election of additional officers for 1916. On the evening of the thirty-first a complimentary smoker was given by the Seattle Commercial Club, at which Professor Meany gave a beautifully illustrated lecture with colored slides on Mt. Rainier. The members were also entertained by a Japanese sword contest and by a Chinese cartoonist. Besides the usual attractions of the excursions and the President's address, the ladies were given special entertainment of a reception and tea on the university campus Tuesday, August 31, and an organ recital the same evening. On Wednesday they were given a special drive by automobile through the parks and boulevards of Seattle. On Wednesday the members were treated to an automobile trip through the beautiful parks and boulevards of Seattle and on Wednesday evening at 8 o'clock, President Charles H. Herty gave his presidential address, entitled "Co-

operation in Matters Chemical,'' before a large audience. On Thursday a complimentary excursion was made on a specially chartered steamer on Puget Sound and refreshments were served to members and guests present. Thursday evening a subscription banquet closed the regular meeting of the society, although other excursions were enjoyed on Friday.

On Friday, September 3, a portion of the members were taken by private yachts on Puget Sound to Tacoma and visited plants there, while a party of twenty-nine took automobiles from Tacoma to Mt. Rainier National Park, over one of the most beautiful drives in America. Saturday spent in Portland as the guests of the Oregon Section. The members were met at the train at 8 A.M. and were taken direct to one of Portland's hotels, where a complimentary breakfast was served. By automobile the members then visited either the new Gas Plant of the city or the Willamette Paper Company works at Oregon City. Following these visits, the members met for a complimentary luncheon at Portland's most beautiful Country Club. After lunch the members were shown around Portland by automobile and met at 4 o'clock to listen to a lecture by Messrs. Burger and Jones, illustrated by colored photography lantern slides showing scenes along the Columbia River and views of Mt. Hood and Mt. St. Helens. This set of views is probably the most remarkable and beautiful chemical reproductions of nature that have ever been shown before an audience. The day was thoroughly enjoyed by members present. On September 5, twenty-five members who had come through together to San Francisco were entertained at dinner at Techau Tavern by the members of the California Section in the usual hospitable manner so characteristic of California chemists. The registration at Seattle showed the presence of 106 members of the society and 119 guests.

The following papers being a continuation of series of papers first presented at New Orleans on the Chemists' Contributions to Industry, were printed in the November *Journal of Industrial and Engineering Chemistry:*

The Contributions of the Chemist to the Naval Stores Industry: JOHN E. TEEPLE.

Contributions of the Chemist to the Iron and Steel Industry: GEORGE W. SARGENT.

Contributions of the Chemist to the Iron and Steel Industry: A. S. CUSHMAN.

Contributions of the Chemist to the Art of Soap Making: M. H. ITTNER.

Contributions of the Chemist to the Perfumery Industry: E. T. BEISER.

Contributions of the Chemist to the Lead Industry: G. W. THOMPSON.

Contributions of the Chemist to the Paint and Varnish Industry: MAXIMILLIAN TOCH.

Contribution of the Chemist to the Photographic Industry: FRANCIS C. FRARY.

Contributions of the Chemist to the Pharmaceutical Products Industry: FRANK R. ELDRED.

Contributions of the Chemist to the Hardwood Distillation Industry: S. W. KATZENSTEIN.

Also the following papers comprising a symposium on the Chemistry of Wood Waste were printed in the November *Journal of Industrial and Engineering Chemistry:*

Chemical Engineering of the Hardwood Distillation Industry: JAMES R. WITHROW.

What Chemistry has done to Aid the Utilization of Wood: S. F. ACREE.

The Tannin Content of Pacific Coast Conifers: H. K. BENSON AND T. G. THOMPSON.

A study of the tannin content of hemlock, spruce and Douglas fir from western Washington was made. Local tanneries use the bark of the western hemlock, which contains above 15 per cent. tannin in commercial practise. From sawmills operating under average conditions bark, slabs and sawdust from cross-cut saws were obtained. These were sampled, extracted and analyzed according to the Official Method of the Leather Chemists' Association. The results of the analysis for tannin reported on a dry basis are as follows:

	Per Cent. Tannin
Fir bark	6.34
Fir slab	5.92
Fir sawdust	1.06
Fir cambium layer	9.92
Spruce bark	5.88
Spruce slab	3.69

Inasmuch as the tannin content of the fir slab approaches that of chestnut wood (6.62 per cent.) and owing to the low cost of fir slabs (less than $2 per cord), it is believed that the extraction of tannin from fir slabs is a commercial possibility. A local tannery used fir extract in the tanning of sheep-skin and reported good quality and a color similar to that obtained from oak tannin.

Yields of By-products from Destructive Distillation of Some Western Conifers: H. K. BENSON AND MARC DARRIN.

The following classes of woods were treated at the Forest Service distillation plant at Seattle:[1]

[1] For design see *Jour. Ind. Eng. Chemistry*, Vol. 5, No. 11.

(1) Douglas fir common run mill waste, (2) Douglas fir selected mill waste, (3) Douglas fir common run stump wood, (4) western yellow pine common run mill waste, (5) western yellow pine common run stump wood, (6) western hemlock common run mill waste. The highest yield of wood alcohol was 5.00 gallons per cord from the hemlock; the lowest 1.83 gallons per cord from the pine stumps; the average yield from Douglas fir common run mill waste was 3.90 per cord against 2.60 from the stumps. The highest yield of acetate of lime was likewise in the case of the hemlock, being 94.0 pounds per cord; the lowest was 55.8 for the fir stumps. This figure was close to that for the pine stumps at 60.3. The yield for the fir common run mill waste was 75.0 pounds per cord, against 74.3 pounds for the selected. The selected Douglas fir mill waste had by far the greatest yields of oils of a turpentine character, being 10.86 gallons per cord. The lowest yield was 2.76 for hemlock. The yield for the fir common run mill waste was 3.40 gallons against 5.59 for the stumps; 4.91 for the pine mill waste, and 6.06 for the pine stumps. Likewise, the selected fir mill waste had the greatest yield of tar, being 46.37 gallons per cord; the lowest yield was 19.88 for the Douglas fir stump wood. The other yields ranged close to the last figure, the largest being 27.80 for the Douglas fir mill waste. The highest yield of charcoal was 977 pounds for the Douglas fir common run mill waste. This figure was followed by those for hemlock and the selected Douglas fir at 938 and 900, respectively. The lowest yield was for pine, being 478 and 520 pounds for the mill waste and the stumps respectively.

From this data the authors find that the most suitable wood for distillation is the Douglas fir selected mill waste, followed by the Douglas fir common run mill waste.

The Use of Ammonium Hydroxide for Extraction of Rosin from Wood: H. K. Benson and Herbert N. Crites.

A five per cent. solution of ammonium hydroxide was used to extract resinous fir wood. Practically complete extraction was obtained when the chips were covered in pressure bottles with a quantity of the ammonia solution equal to eight times the weight of the wood at a temperature of 70° C. for five hours. The chips were washed with a quantity of five per cent. ammonia solution equal to twice the weight of the wood to recover the one per cent. rosin adhering to the chips. Rosin dissolves in ammonium hydroxide to form ammonium resinate, which upon heating to 100° C. decomposes, forming ammonia and leaving a residue of rosin and "humus." The ammonia is recovered by the method used in gas works and again used in the process. The mixture of rosin and "humus" is then agitated with gasoline, whereby the rosin goes into solution from which the "humus" is removed by filtration. The rosin solution is evaporated, the gasoline being condensed and recovered and the molten rosin run from the still into containers, where it solidifies upon cooling. The "humus" is in the form of a brown powder and other investigations show its suitability for the manufacture of dyes. From resinous fir wood 700 pounds rosin and 500 pounds "humus" per cord were obtained.

Discoloration of Maple in the Kiln: Roy C. Judd.

The Chemical Composition of the Light Oil from the Destructive Distillation of Resinous Woods: R. E. Rose and A. G. Bissell.

The Manufacture of Ethyl Alcohol from Wood Waste. II. The Hydrolysis of White Spruce: F. W. Kressmann.

A continuation of the work previously prepared has shown first that the ratio of water to dry wood is without appreciable influence as long as sufficient water is used to dilute the acid so as to give an intimate mixture of acid with wood. In the former work, the ratio of water to dry wood was 400 to 100, which has been reduced to 100 to 100, although the ratio of 125 parts of water to 100 parts of dry wood is recommended, since this will give a digested sawdust free from drip. The ratio of the catalyzing agent (sulphuric acid) to dry wood has been varied from 5 parts per thousand (0.5 per cent.) to 40 parts per thousand (4 per cent.). Two and one half per cent. of acid was found to give the best results, considered both from a total sugar and from fermentable sugar standpoint. The variation of the concentration of catalyzing agent in the water added was found to be without effect so long as the actual amount of catalyzing agent as compared to the dry wood was not varied. With instantaneous cooks and with increasing concentration with sulphuric acid, the yield of alcohol increased from 4.17 per cent. with .5 per cent. sulphuric acid up to 7 per cent. with 4 per cent. sulphuric acid. It was found, as reported previously, that the sugar yields did not vary with the time of cooking, but more careful fermentation work has shown that although the total sugar yield does not vary appreciably, the percentage of that sugar which is fermentable increases with increased time of cooking. A 20-minute cook at 7½ atmospheres pressures with 2½ per cent. sulphuric

acid and 125 per cent. of water gave an alcohol yield of 8.54 per cent. of the dry weight of the wood or about 25 gallons per dry ton.

The Application of the Davis Spot Test in the Preliminary Examination of Creosotes: HOMER CLOUKEY.

Isoprene from Beta-pinene: A. W. SCHORGER AND RALPH SAYRE.

The Distillation of Douglas Fir at High Temperatures: BAILEY TREMPER.

The Manufacture of Ethyl Alcohol from Wood Waste. III. Western Larch as a Raw Material: F. W. KRESSMANN.

The butt log of western larch is usually left in the woods because of the presence of shakes and also because of the weight of the log, which is heavier than water and, therefore, sinks, preventing rafting. An investigation of this material showed a sugar yield of 29.7 under the same conditions that would yield about 22 per cent. from white spruce. However, only 37.9 per cent. of the larch sugar was fermentable against from 60 to 65 per cent. of total sugar fermentable from spruce. Analysis of the larch by Mr. A. W. Schorger of this laboratory showed only 42½ per cent. of cellulose as compared with about 56 per cent. from spruce and also the presence of about 12 per cent. of galactan, which yielded galactose on hydrolysis, which, however, was not fermentable by the yeast used. Calculations show that the proportion of fermentable sugars to cellulose is about the same for larch as for spruce. If a yeast is found which will ferment the galactose as well as the dextrose within the time limits and other limitations, as prescribed by the Bureau of Internal Revenue, this material will afford a very good raw material for the production of ethyl alcohol.

The Production of Acetone from Pyroligneous Acid: MARC DARRIN.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

Floyd W. Robinson, Chairman

Glen F. Mason, Secretary

The Activity of Proteolytic Enzymes in Breadmaking: ARNOLD WAHL.

The Spontaneous Decomposition of Butter Fat: C. A. BROWNE.

The analytical constants are given for a number of butter fats exposed to the light and air before and after a period of 15 years. The results show that the fats have undergone an increase in the acid, saponification and volatile acid numbers and a decrease in the ether and iodine numbers. The mean molecular weight of the free volatile acids was 91.7 and of the combined volatile acids 105.4; the average mean molecular weight of the total volatile acids was 99.5, which agrees closely with that for normal butter fat. The total percentage of volatile acids had increased from 7.2 per cent. to 8.6 per cent. and the total percentage of insoluble acids had decreased from 87.6 per cent. to 79.7 per cent. The insoluble acids had an acetyl number of 36.4 corresponding to 20 per cent. of hydroxy-stearic acid and an ether number of 8.3 corresponding to 4.2 per cent. of stearo-lactone. A proximate analysis of the decomposed butter fat gave 63.50 per cent. neutral fat, 27.15 per cent. free insoluble acids, 3.90 per cent. free soluble acids, 5.42 per cent. undetermined. The iodine number of the free insoluble acids was 11.3 and of the combined insoluble acids 12.1. Experiments upon the change in weight which butter fats undergo with age showed that there was a 2 per cent. to 3 per cent. increase in weight in about one year, the period of greatest increase being about the tenth week. Very old butter fats lose in weight, owing to the escape of water, carbon dioxide, volatile acids and aldehyde decomposition products. The theories of the spontaneous decomposition of fats are discussed; the author believes that the observed facts are best explained by supposing an absorption of oxygen molecules from the air at the unsaturated bonds, one atom of active oxygen being liberated for each atom of oxygen absorbed. The disintegration of the glycerides, being proportional to the percentage of unsaturated acids, is attributed to the action of the active oxygen. Experiments are cited to prove that such atoms of active oxygen are formed.

The Analysis of Maple Products. V. Miscellaneous Observations on Maple Syrup Incidental to a Search for New Methods of detecting Adulteration: J. F. SNELL.

(1) Silver nitrate added to maple syrup gives a white precipitate which darkens on standing. The precipitation of silver continues during a period of several hours. (2) Mercuric acetate added to maple syrup produces a light yellow precipitate. (3) Alcohol produces a precipitate containing most of the calcium and potassium. (4) A moderately successful attempt was made to combine the advantages of the Winton and Canadian lead subacetate methods. (5) The Canadian lead precipitates from six syrups showed a lead content of 66.95 to 69.62 per cent. Average 68.42. The precipitate from a composite of 542 syrups contained 69.41 per cent. of lead, while

that from another mixed syrup contained 70.11 per cent. (6) Titration of maple syrup with $N/50$ silver nitrate (*a*) directly, using electrical resistance measurements to detect the end point (b) after treatment with lead subacetate, or alumina cream, using potassium chromate as indicator yielded definite but not useful results. (7) Titration with uranyl acetate gave no useful results. (8) Titration with lead subacetate solutions using electrical resistance as indicator led to a useful method of testing the syrup for purity, which is described in the next paper of the series.

A Volumetric Lead Subacetate Test for Purity of Maple Syrup: J. F. SNELL, N. C. MACFARLANE AND G. J. VAN ZOEREN.

(1) The volumetric lead subacetate test consists in diluting the syrup to ten times its original volume and titrating with lead subacetate solution of sp. gr. 1.033, obtaining the end-point by measurements of electrical resistance. (2) The volumetric lead number is the abscissa of the point of intersection of two straight lines on the plot of volumes as abscissæ with resistance as ordinates. (3) Seventy genuine Quebec 1914 and 1915 syrups gave volumetric lead numbers ranging from 4.8 to 6.6—a range of 37.5 per cent. of the minimum as compared with 97 per cent. for the conductivity value. Twenty-eight of these syrups showed a range of 75 per cent. for the conductivity value and 339 per cent. for the Canadian lead number, while the range of volumetric lead number was the same as in the whole 70. (4) Seventeen out of 20 syrups containing 30 per cent. of sucrose syrup gave smooth curve plots. Eighteen out of 20 containing 40 per cent. sucrose syrup gave smooth curves and the remaining two gave intersections outside the limits for genuine syrups. Of 14 adulterated and non-maple syrups 10 gave smooth curve plots, 2 gave intersections outside the limits found in genuine syrups and in the remaining 2 (cane molasses) the electrical resistance remained constant.

The Electrical Conductivity Test for Purity of Maple Syrup. Corrections and Supplement to Paper I.: J. F. SNELL.

(1) A number of minor corrections to paper I., as published in the *Journal of Industrial and Engineering Chemistry*, are noted. (2) The directions are modified to suit a new type of electrode. (3) Experience with the test has shown that the limits of variation of the conductivity value in genuine syrups are wider than appeared when paper I. was published. However, these limits are still narrower than those of any of the older analytical values.

The Determination of Total Solids in Milk by Open-Air and Vacuum Methods: GEO. GRINDROD.

Results obtained by several different methods of drying are given and the methods compared as to accuracy. Moisture absorbed by milk residues was found to cause them to lose weight when further heated. Repeated weighing till minimum weight is reached, as usually practised, is liable to cause erroneous results on account of moisture absorbed during weighing. Repeated analyses of samples from the same lot of condensed milk over a period of one year show atmospheric pressure drying subject to error. Vacuum apparatus especially adapted to determination of total solids in milk is described. Results by this apparatus found more accurate than other methods.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

G. A. Hulett, Chairman

R. C. Wells, Secretary

Anodic Relations of Passive Iron: H. G. BYERS AND SETH C. LANGDON.

Electrolytic Endosmose: RUBY CLIFT AND GEORGE GLOCKLER.

The Stabilizing Influence of Hydrogen Sulfide on Colloidal Metallic Sulfide Solutions: S. W. YOUNG.

Equilibria Internary Systems containing Alcohols, Salts and Water: GEORGE BELL FRANKFORTER AND STERLING TEMPLE.

A study was made of the use of some salts to determine the per cent. of alcohols in mixtures of alcohol and water by means of the amount of salt which could be added without causing a separation into two layers. Curves were drawn and directions given for the use of the method. The following systems were investigated: Propyl Alcohol–Sodium Carbonate–Water, Isopropyl Alcohol–Potassium Fluoride–Water, Isopropyl Alcohol–Potassium Carbonate–Water, Allyl Alcohol–Potassium Fluoride–Water, Allyl Alcohol–Potassium Carbonate–Water, Allyl Alcohol–Sodium Carbonate–Water and Allyl Alcohol–Sodium Chloride–Water. This work together with the work of Frankforter and Frary indicates that potassium fluoride and potassium carbonate can be very successfully used for a quick method of determining the strength of solutions of ethyl, propyl, isopropyl and allyl alcohols. The evidence did not support the hypothesis that the salting out power of a salt could be predetermined from a knowledge of the ions in the solution, but showed that it was rather a function of the amount of water which the salt took up to form its hydrates, the

solubility of the salt and of its hydrates both in water and in alcohol and the ability of the alcohol to displace the water of combination.

Equilibria in Systems of Ketones, Water and Salts with a Method for the Determination of Methyl Alcohol in the Presence of Acetone: G. B. Frankforter and Lillian Cohen.

The Influence of Dissolved Substances upon the Velocity of Crystallisation of Under-cooled Water: James H. Walton, Jr., and A. C. Brann.

The velocity of crystallization of under-cooled water has been measured at — 9°, and the inhibiting effect of dissolved substances—such as acids, alkalies, salts, alcohols and some colloidal substances—determined. When possible tenth molecular solutions were used. It has been found that a rough proportionality exists between the number of atoms in the molecular and the inhibiting effect. The greater the number of atoms in a molecule of dissolved substance the slower the rate of crystallization.

The Partition Coefficients of Hydrogen Peroxide between Water and Certain Organic Solvents: James H. Walton, Jr., and H. A. Lewis.

Hydrogen peroxide is soluble in many organic solvents, such as phenol, aniline and certain esters. In general, any organic liquid that dissolves water will dissolve hydrogen peroxide. A determination of the partition coefficient in most of these solvents shows a normal molecular weight for the peroxide. In Quinoline the partition coefficient water: quinoline, is about 1: 3. This ratio changes with change of concentration of hydrogen peroxide, pointing to association of the molecule in the quinoline solution. The partition coefficient water: quinoline, has been studied at various temperatures.

The Preparation of Pure Iron and Iron Carbon Alloys: J. R. Cain, E. Schramm, and H. E. Cleaves.

It is shown that previous work on the iron-carbon diagram is unsatisfactory because of the great variation in the materials used. It was therefore thought necessary to produce a series of alloys of great purity to form the basis of a redetermination of the diagram at the Bureau of Standards. The general method pursued consisted in melting electrolytic iron with sugar carbon in magnesia crucibles. The electrolytic iron was prepared from ingot iron anodes in a chloride bath with or without the use of porous cups. The operation of melting the iron with carbon gave great trouble at first, because the ingots obtained were full of blow-holes and contained considerable quantities of impurities. The difficulties were overcome by melting in a vacuum furnace, and making crucibles of especially pure magnesia, made and calcined with great care at the Bureau of Standards. A satisfactory procedure was finally worked out and a series of alloys prepared of the composition $Fe + C = 99.96$ per cent.

The Oxides of Iron. I. Solid Solution in the System Fe_2O_3—Fe_3O_4: Robert B. Sosman and J. C. Hostetter.

This investigation of the chemical relationships of the iron oxides has been undertaken as a basis for the study of the iron-bearing silicates at high temperatures. Measurements of the dissociation pressure of the iron oxides were made in a vacuum furnace with a heating tube of platinum-rhodium. A study of the conditions of equilibrium shows that reproducible oxygen pressures can be obtained at a given temperature. Equilibrium is attained in a few minutes at high temperatures, although certain disturbing reactions go on slowly. One of these by-reactions is the reduction of the oxide by platinum, yielding oxygen and an iron-platinum alloy. Another is a slow disappearance of oxygen, which has not been satisfactorily explained. Ferric oxides from various sources yield practically identical pressures. The same pressures are also attained on both rising and falling temperatures. The oxidation of magnetite gives pressures which are a little higher than those produced by dissociation of Fe_2O_3. The pressure-composition isotherm for the system Fe_2O_3—Fe_3O_4 at 1,200° indicates a continuous solid solution series from Fe_2O_3 over to a point very near Fe_3O_4, if not over the entire range to Fe_3O_4. The opacity of the products prevents an optical demonstration of the existence of solid solution in products with more than 18 per cent. FeO, but its existence can be shown optically in products which are more ferric than this. The pressure-composition isotherm at 1,100° confirms that at 1,200°. The major portion of the oxygen pressure curve of the system at 1,200° lies between the limits 4 mm. and 1.5 mm. The pressure drops rapidly near Fe_3O_4, and rises rapidly near Fe_2O_3. Since the dissociation of Fe_2O_3 results in the formation of a solid solution, the pressure of oxygen and the composition of the solid phase depend upon the relation of the weight of the charge to the volume of the space into which the oxygen dissociates. This fact accounts for the variety and un-

certainty of results heretofore obtained in experiments on the dissociation pressure of Fe_3O_4.

The Water Correction in Conductivity Determinations: JAMES KENDALL.

Conductivity water, however carefully prepared, can not be kept for more than a short period in contact with air without its specific conductivity rising to about 0.9×10^{-6} reciprocal ohms (at 25° C.). This value represents also the specific conductivity of pure water saturated with CO_2 under the ordinary atmospheric partial pressures (3.69 parts in 10,000). It is therefore possible to obtain accurate conductivity values for very dilute solutions of any electrolyte by applying a correction for carbonic acid. This has been done for strong electrolytes (Arrhenius), transition electrolytes (Kendall), and weak electrolytes (Walker and Kendall). The results obtained indicate conclusively the accuracy of the corrections so applied.

Conductance Data and Empirical Equations: STUART J. BATES.

The application to experimental data of empirical equations or of the similar but less sensitive method of plotting the results, is of value chiefly as a means of interpolation and of judging the accuracy of data. However, in the latter case great caution must be employed. This is illustrated by the fact that as a result of the application of the Kraus equation to the conductance data for KCl, the data below 0.001 N were rejected as inaccurate. It is found, however, by the application of the equation

$$\log \frac{C_i^2}{C_u} = K + TX^m,$$

where $X = C_i$, C_u or C, to these data, that they are consistent. The data for KCl between 1.0 N and 0.0001 N agree with this equation with an average deviation of but 0.03 per cent. when $X = C_i$ or C_u and of 0.07 per cent. when $X = C$. The above equation is applicable to other aqueous solutions and to non-aqueous solutions. It is apparently as generally applicable as that of Kraus. However, in the case of salts such as KNO_3 which give a minimum value for n (the exponent in Storch's equation), neither the equation of Kraus nor that given above is capable of representing the data throughout the entire concentration range.

A Quantitative Measure of the Deviation from the Law of Mass Action: STUART J. BATES.

The strict obedience of an electrolyte to the law of mass action may be readily tested by observing the constancy of the equilibrium expression C_i^2/C_u. However, this does not afford a quantitative means of judging the magnitude of the deviations at different concentrations of two or more electrolytes. For example, which deviates the more, dichloracetic acid at 0.1 N or KCl at 0.001 N? The equilibrium expression for a strong electrolyte corresponding to any concentration may be calculated, but there is nothing with which to compare it, for in this case the uncertainty in the "ionization constant at infinite dilution" which is a true constant in the case of weak electrolytes, is often as great as 1,000 per cent. However, if the law of mass action is obeyed by a diionic electrolyte at a certain concentration, then the exponent n in Storch's equation $C^n/C_u = K$, has the definite and theoretical value 2. By comparing the value which n does have at a given concentration with this value (2), a quantitative measure of the deviation is given. Let $d = (2 - n)/n$, then if $d = 0$ the mass law is obeyed. The greater d is, the greater the deviation; d may be either positive or negative. Since in general n changes with the concentration, d changes with the concentration, becoming smaller with decreasing concentration. The undissociated molecules are in general largely responsible for the deviation from the law of mass action. Since their behavior may be readily expressed in terms of osmotic pressure, d has been defined so that it is an approximate measure of the deviation of these molecules from van't Hoff's law.

Ion Concentration and the Law of Mass Action: STUART J. BATES.

The deviation of solutions of strong electrolytes from the law of mass action is usually considered to be due to the presence of the charged ions in the solutions. This view has an *a priori* possibility and is considered by many to be supported by two facts. The first is that the conductance of solutions containing two salts may be readily calculated upon the isohydric principle. Bray and Hunt have pointed out, however, that the conductance may be calculated upon the basis of the total concentration also. The second is that the equilibrium expressions of strong electrolytes may be readily expressed as functions of the total ion concentration, as for example, by the equations of Storch and of Kraus. But the expression may be equally well represented as a function of the total concentration or of the concentration of the undissociated molecules. (See preceding abstracts.) Direct proof that the ion concentration does not control the thermodynamic environment of the so-

lution, that is, that it does not materially influence the deviation from the law of mass action, is afforded by a comparison of the magnitude of the deviation at various ion concentrations for different electrolytes. Thus at the ion concentration 0.001 N, d for KCl equals 0.29, for dichloracetic d is less than 0.003 and for acetic acid it has a small negative value. At the ion concentration 0.05 N, the values for the first two electrolytes are 0.40 and 0.06, respectively. Evidently there is no parallelism between ion concentration and the magnitude of the deviation from the law of mass action. The former does not control the latter. The osmotic pressure or activity of the undissociated molecules depends largely upon their type. They are more abnormal the stronger the electrolyte.

The Calorimetric Determination of Ferrous and Ferric Iron: O. L. BARNEBEY.

Differential Iodimetry. I. The Titration of Periodates, Iodates, Bromates and Chlorates in the Presence of Each Other and in the Presence of Perchlorates: O. L. BARNEBEY.

Molecular Weights of Gases by an Evaporation Method: H. L. TRUMBULL.

That liquids evaporate into different gases at different rates was first pointed out by Stefan. Winckelmann, and Guglielmo extended the work of Stefan, to include many liquids, and a general agreement between all their results was noted, viz.: that evaporation is most rapid into hydrogen and correspondingly less rapid into heavier gases. The methods employed by the earlier investigators were not all that could be desired, being at fault in the matters of temperature control, elimination of wind currents, and the employment of a height loss, rather than a weight loss method.

The object of this investigation was to find a simple and accurate method for the measurement of rates of evaporation of water into different gases, with a view to the relations between the rates and densities of the gases used. These experiments were conducted in a perfectly dry atmosphere, free from air currents, at a constant temperature of $25°.07 \pm 0°.01$, and by a weight loss method. A comparison of the evaporation constants obtained in this experiment leads to the following results. The predicted values of the relative diffusion rates on the basis of Graham's law are hydrogen to air, 3.79, hydrogen to CO_2, 4.67, air to CO_2, 1.24. The means of the corresponding rates by this evaporation method are 3.37, 4.68, and 1.393. Various applications are cited.

Production of Potassium Chlorate from Kelp: H. L. TRUMBULL AND H. C. HOWARD.

Electrolysis of a solution obtained by pressing and lixiviating the kelp produces chlorates with a current efficiency of 50 per cent. and an energy expenditure of 7K.W.H. per pound of chlorate. No purification of the raw material is required. Because of the great difference in solubility of the sodium and the potassium chlorates the latter is easily obtained in a pure state.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

Geo. P. Adamson, Chairman

S. H. Salisbury, Jr., Secretary

Additional papers not read in symposiums.

Refining Vegetable Oils: CHAS. BASKERVILLE.

The Relation of Water Power to Chemical Industry: HENRY J. PIERCE.

"Viscosimeters": R. F. MACMICHAEL.

The Function of Cooking Fossil Resins in Varnish Manufacture: W. L. JEFFRIES AND CHAS. H. HERTY.

A Test of a Surface Combustion Furnace: E. SCHRAMM AND J. R. CAIN.

In view of the fact that the surface combustion process appeared to offer many advantages for high-temperature laboratory furnaces, it was decided to submit a crucible furnace of this type to a thorough test. For the purpose, the furnace was equipped with meters on the gas and air lines and with a chimney to permit the collection of flue gas samples. In several runs the mixture proportions were maintained constant, while varying the rate of gas consumption. Temperatures were read by a Hollborn-Kurlbaum optical pyrometer. The highest temperature reached was 1675° C., at which point the alundum muffle failed. The test established that complete combustion could be attained without excess air, that the best air: gas ratio was 5.5, and that a 20-per-cent. excess of air caused a lowering of furnace temperature of 100°.

BIOLOGICAL CHEMISTRY DIVISION

Carl L. Alsberg, Chairman

I. K. Phelps, Secretary

Mutual Action of Similarly Charged Colloids: W. D. BANCROFT.

Adsorption of Colloids by Liquids: W. D. BANCROFT.

Formation of Surface Films: W. D. BANCROFT.

A Search for Hydrocyanic Acid in the Caprifoliaceæ: C. L. ALSBERG.

A number of American species of the Caprifoliaceæ were tested for hydrocyanic acid, because those reported from other countries showed the presence of hydrocyanic acid. Those tested showed none, either on hydrolysis with acid alone or with emulsion also present.

The Reaction of the Pancreas: J. H. LONG AND F. FENGER.

The pancreatic juice of man and the domestic animals, as collected by a fistula, is known to have a rather marked alkaline reaction. No attention has been paid to the reaction of the press juice of the organ itself. This may be separated by pressure from the minced gland, but very perfectly by aid of one of the powerful laboratory centrifuges now in use. In the experiments carried out by the authors the centrifuge tubes were charged with about 75 grams of the minced organ, each, and given a speed of 3,000 revolutions per minute through 45 minutes. The clear liquid separated, the real pancreatic juice, had a distinct acid reaction in the cases of the beef, hog and sheep pancreases, and nearly constant in degree. It was found to lie between $C = 25 \times 10^{-7}$ and 30×10^{-7}. The reaction may be found to be as characteristic as that of the blood and is doubtless related to it. In the physiological activity of the organ an acid fraction seems to be retained, while an alkaline fraction is thrown to the duodenum. A rearrangement of the phosphate and carbonate groups of the blood would account for both reactions. In this centrifugal separation, besides the liquid, a lower layer of matter largely protein is obtained and an upper layer of fat and protein. The fresh minced gland, also, shows the acid reaction.

On the Digestive Activity and Composition of Separate Fractions of the Pancreas: J. H. LONG, MARY HULL AND H. V. ATKINSON.

As shown in the preceding abstract, the minced pancreas may be readily separated into three fractions by rotation in a powerful centrifuge. The authors have found the relative volumes of these fractions somewhat variable, depending on the speed and duration of rotation. The lower layer may make up fifty per cent., or more, of the whole, and is largely protein. It exhibits both amylolytic and tryptolytic activity. The middle layer is liquid and usually makes twenty to twenty-five per cent. of the contents of the centrifuge tube. The starch-converting power of this liquid is sometimes very strong, especially in the case of the hog pancreas, where one part of it has been found to convert over 150 parts of starch to the colorless end-point in ten minutes. Trypsin is also present, and no activator is required to bring out its power. The top layer contains much fat and some protein and is deficient in ferment activity. The fat is rich in phosphorus, pointing to the presence of lipoid bodies of the lecithin type. The freezing-point of the liquid layer is apparently a constant for the product from each animal, provided the maximum of liquid is obtained. For the beef product the value was found to be about -1.12 and for the hog -1.62. The investigations are being continued.

Kelp: F. K. CAMERON.

The Inadequacy of Schultz's Valency Rule: W. D. BANCROFT.

The Evolution of the Yeast Type especially Adaptable for Bread-making: A. WAHL.

A Theory regarding Protoplasmic Structure, based on the Study of Emulsion Equilibrium: G. H. A. CLOWES.

Alleged Abnormal Adsorption of Filter Paper: W. D. BANCROFT.

Adsorption of Acids by Cellulose: W. D. BANCROFT.

Oxycellulose: W. D. BANCROFT.

Boron—Its Absorption and Distribution in Plants and Its Effect on Growth: F. C. COOK.

Boron was applied to manure as a larvicide for the fly maggot, either as borax or calcined colemanite. The effect of the boron-treated manure on plant growth was studied at Arlington, Virginia, Dallas, Texas, New Orleans, Louisiana, and Orlando, Florida, and various plants and soil samples were analyzed for boron. Boron was absorbed by the plants from the calcined colemanite plats in the same amounts as from the borax plats. Lime added to the manure with the borax had no definite action in preventing the absorption of boron.

Potatoes, string beans, soy beans and cow peas showed a more equal distribution of the boron among the roots, tops and fruit than was the case with the wheat, beets, tomatoes, radishes and lettuce plants analyzed. In some cases very little boron was found in the roots or fruit, while a considerable amount was found in the rest of the plant. All control plants contained at least a trace of boron. Some control samples of soil contained boron soluble in weak hydrochloric acid, while several of the boron-treated plats several months after boron was added showed none soluble in weak hydrochloric acid in the upper six inches of soil. If sufficient boron was added to the soil a yellowing of the leaves took place, but this does not neces-

sarily indicate that the yield will be affected. The leguminous plants were more sensitive to boron than the other plants tested. Variations in soil, climate and the resistance of different varieties make it impossible to give a figure for the amount of boron which all plants can stand with impunity.

Boron, Its Absorption and Distribution in Plants and Its Effect on Growth: F. C. Cook.

A Study of the Calcium and Magnesium Metabolism in a Case of Chronic Gout: Jacob Rosenbloom.

Metabolism Studies in a Case of Bronchial Asthma: Jacob Rosenbloom.

Note on Semipermeable Membranes: W. D. Bancroft.

Dilute Solutions of Gelatine: W. D. Bancroft.

Nephelometric Estimation of Phosphorus: Philip Adolph Kober and Grete Egerer.

(1) The reagent of Pouget and Chouchak has been modified so as to be: (*a*) stable, (*b*) colorless, (*c*) quantitatively and (*d*) nephelometrically applicable. (2) It is shown that 0.005 milligram of phosphorus in 10 c.c. of solution, or some part of phosphorus in two million parts of water is easily determined quantitatively with the nephelometer.

Spectrographic Study of Amino Acids and Polypeptides: Philip Adolph Kober, with the assistance of Walther Eberlein.

(1) The absorption of aliphatic amino acids, in acid or alkaline solution, is only general, in the extreme ultra-violet. (2) The aromatic amino acids show absorption bands, which may be useful in detecting their presence in peptide chains. (3) The presence of an excess of alkali with these substances seems to increase the amount of absorption and tends to shift it towards the red end of the spectrum. (4) The absorption of di- and tri-peptides in acid or alkaline solution showed no special absorption, it being similar to that of the free amino acids. (5) The lack of special absorption of the peptides in alkaline solution; and other points which were discussed, show that the keto-enol tautomerism in peptide linkings, as suggested by Dakin and Dudley, in explanation of the "racemization" of proteins, is doubtful and unsupported.

Production of Citric Acid by Black Aspergillus: James N. Currie.

The acidity of young cultures of black *Aspergillus* (*A. niger*) was found to be greater in many cases than could be accounted for by the oxalate radical present. A study of this problem revealed the fact that citric acid to the amount of 0.3 to 0.4 gram per 100 c.c. of media was present. The citric acid seems to be a transitory product which appears almost as soon as the mold begins to develop, reaches a maximum in 3 to 4 days, then declines and in most cases disappears within a week.

Production of Oxalic Acid by Aspergillus Ficuums: James N. Currie.

The literature of fungi records *Aspergillus niger* as the oxalic acid ferment par excellence and states that this mold will produce one per cent. of free oxalic acid on sugar media. A culture of *Aspergillus ficuum,* Schiemann, which has come under our observation produces on cane sugar media under favorable conditions 2.7 to 3.0 per cent. of free oxalic acid and in the presence of $CaCo_3$ give a yield of 80 per cent.

An Oxalic Acid Producing Penicillium: James N. Currie and Charles Thom.

A green penicillium common on moldy corn and corn meal was observed to produce large amounts of oxalic acid. This mold resembles *P. italicum* of Wehmer in morphology, but differs so widely from that species in appearance and habits that we propose the name *P. oxalicum.* On a 5 per cent. sugar medium it produces an acidity of about 0.8 per cent., calculated to $(OOOH)_2, 2H_2O$, in one week, and in the presence of $CaCO_3$ converts 40 per cent. of the sugar to oxalic acid. This is much the most active oxalic-acid producer ever observed among the penicillium.

Quantitative Changes in the Growth of the Human Brain: E. A. Dorsey and C. G. MacArthur.

The per cent. of solids increases with age to maturity. The cerebrosides and sulfatids are not found in fetus or brains up to a year old. From that time on they increase gradually with age to maturity. The proteins and phosphatids become larger in percentage amounts from three-month fetus to nineteen-year brain. From that age on most of the constituents are nearly constant.

Respiration of Nervous Tissue: O. C. Jones and C. G. MacArthur.

A comparison of the various parts of the nervous system showed that the cerebrum and cerebellum respire fastest. Then, mid-brain, corpus callosum, medulla in the order named. The spinal cord takes up about half as much oxygen and gives off about half as much carbon dioxide as the cerebrum. The sciatic nerve, however, respires but half as fast as the spinal cord. Of the different animals, in general, the older and larger respire more slowly, per gram of tissue, than the younger and smaller. This investigation was carried out

with a modification of the Mathews-Bunzel oxidation apparatus on very fresh tissue.

Nitrogenous Products from Brain Lecithin: J. Darrah and C. G. MacArthur.

There is about 0.2 per cent. nitrogen in brain lecithin in an unknown form. This remains in the fatty acid residue after hydrolysis of the lecithin. About 0.8 per cent. nitrogen is present as chlorine. This was confirmed in the usual way as the platinum compound. The other 0.8 per cent. of the nitrogen was identified as amino ethyl alcohol both by the gold salt and by the picrolonate derivative.

Some Physico-Chemical Properties of Several Brain Lipoids: G. Niederman and C. G. MacArthur.

Respiration of Nerve Tissue: O. C. Jones and C. G. MacArthur.

Some Effects of Large Applications of Certain Commercial Fertilizers: George D. Beal and Fred Weaver Muncie.

In connection with the study of fertilizers for greenhouse crops, the author has investigated the effects of excessive applications of certain commercial fertilizers upon carnations. The fertilizers chosen for this purpose were ammonium sulfate, dried blood, commercial acid phosphate, disodium phosphate and potassium sulfate. It was found that the ease and rapidity with which overfeeding effects appeared depended in a general way upon the solubility of the fertilizer in water, and three classes were distinguished: (1) those fertilizers quite soluble and producing immediate injury when applied in large quantities; (2) those fairly soluble and producing delayed injury, and (3) those difficultly soluble and producing no injury when applied in any quantities. Ash and mineral determinations showed the increased intake of the fertilizing salts when large quantities were applied. The total nitrogen content of the plants could be increased nearly threefold when ammonium sulfate was applied to the soil. Serious injury followed the use of large quantities of it, although the plants acquired a certain tolerance when the salt was applied over a long period in small quantities. Free ammonia (as ammonium salts) was found in plants so fed. Lime decreased the intake of sulfate and phosphate, but increased the injury from ammonium sulfate. Osmotic pressure determinations on the sap from shoots (expressed after freezing) showed that with any single fertilizer the increased intake of the salt, and after injury became apparent, the greater degree of injury was correlated with a higher osmotic pressure value. The value at which injury became noticeable was different for the different fertilizers, being lowest for ammonium sulfate and highest for potassium sulfate. Total solids determinations on the sap from plants treated with the latter salt were abnormally high. A study of the sugar content of the sap by polarimetric and gravimetric methods showed a larger percentage of sugars in this sap than in that from plants normally fed. This increase was shown to be due to a larger amount of maltose. Starch determinations made on the foliage showed a lower content of starch corresponding with the higher maltose value. Under greenhouse conditions applications of ammonium sulfate caused an increase in the total acidity of the sap expressed from the shoots. Potassium sulfate caused no change. Sodium phosphate (di) although slightly alkaline to phenolphthalein itself caused an increased total acidity in the sap. This was shown to be due to increased amounts of dihydrogen phosphate in the sap, and the intake of the phosphate from this monohydrogen salt in form of the dihydrogen phosphate to be true in water culture as well as in soil.

Improved Methods for the Separation of the Higher Saturated Fatty Acids and the Properties of Alfalfa Seed Oil: C. A. Jacobson.

DIVISION OF PHARMACEUTICAL CHEMISTRY

F. R. Eldred, Chairman

A. P. Sy, Secretary

The Alkaloidal Content of Hyoscyamus grown in Minnesota: E. L. Newcomb.

N. and H. advise treating biennial henbane seed with conc. H_2SO_4 for two and one half minutes in order to secure early and uniform germination. Untreated seed give very variable germination results.

The observation of two species of biennial *Hyoscyamus niger* which possess the semi-latent capacity of growing as annuals is reported. The basal leaves of the biennial *H. niger* lose about 9 per cent. of moisture upon drying. The lamina yield from 14.2 to 14.8 per cent. of ash and 0.0896 per cent. of total alkaloids. The petioles of the basal leaves lose 91.6 per cent. of moisture upon drying, yield from 18.9 to 18.8 per cent. of ash and from 0.0896 to 0.1012 per cent. of total alkaloid. The flowering tops of *H. niger* annual lose 85.06 per cent. of moisture upon drying, yield from 11.41 to 11.66 per cent. of ash and from 0.1301 to 0.1561 per cent. of total alkaloid. The flowering tops of *H. niger* annual var. *pallidus* lose 84.8 per cent. of moisture upon drying, yield

from 11.99 to 12.33 per cent. of ash and from 0.1243 to 0.1301 per cent. of total alkaloid. All samples reported upon were prepared from plants cultivated in the Medicinal Plant Garden, College of Pharmacy, University of Minnesota.

Some Notes on Sandalwood, Its Assay, Yield of Oil, and Changes in the Oil during Distillation: C. H. Briggs.

Iso-pulegol Phosphonic Acid: Francis D. Dodge.

The writer has made a further examination of the crystalline acid, containing phosphorus, resulting from the reaction of phosphoric anhydride on citronellal.

The compound is very stable, and yields a series of well-crystallized salts. By dry distillation of the sodium salt, a volatile alcohol was obtained, apparently identical with the iso-pulegol of Tiemann, a cyclic isomer of citronellal. The acid is then most probably a phosphonic acid of iso-pulegol, and hence a very characteristic derivative of citronellal.

Attempts to demonstrate the presence of citronellal in oil of lemon, by means of this reaction, were unsuccessful.

Note on the Use of the White Mouse as a Test Animal for Determining the Toxic Coefficients of Various Drugs: J. H. Beal, C. G. MacArthur and E. A. Doisy.

Color Standards and Colorimetric Assays: H. V. Arny.

Electrolytic Determination of Mercury in Mercury Oleate: B. L. Murray.

Electrolytic Determination of Bismuth in Bismuth Betanaphthol: B. L. Murray.

Electrolytic Determination of Mercury in Mercury Salicylates: B. L. Murray.

A rapid and convenient method of determining mercury in mercury salicylates is herewith presented. It consists in a new application of the already well and favorably known electrolytic deposition of mercury. The method here given as used on salicylates of mercury has been in use about two years and has proved reliable.

About 0.3 gram is weighed into the mercury cathode dish and dissolved in 10 c.c. of sodium sulphide solution (sp. gr. about 1.18). To this solution are added 20 c.c. of 10 per cent. potassium hydroxide solution. The mixture is now electrolyzed, using a current of 1 ampere and 7 volts until the mercury is completely deposited, usually about one half hour being required. The anode should rotate about 500 revolutions per minute. After the deposition the electrolyte is decanted, the mercury is washed with water until free from alkalinity, then with alcohol, finally with ether, and then weighed.

Hardness, Weight and Thickness of Medicinal Tablets: A. D. Thorburn.

The Rate of Evaporation of Ether in Oil-Ether Anesthesia: Chas. Baskerville.

The Identification of the Emodin Containing Drugs: Geo. D. Beal and Ruth E. Okey.

Some New Laboratory Methods: Albert Schneider.

DIVISION OF ORGANIC CHEMISTRY

F. B. Allan, Chairman

C. G. Derick, Vice-chairman and Secretary

The Chemistry of Enzymic Action: J. U. Nef.

The First of the Enzymes and Its Evolutionary Significance: R. G. Eccles.

(1) The prototrophic bacteria as the most primitive known organisms on the earth.[2] Metabolism of *Nitroso-coccus* of South America, and *Nitoso-monas* of Europe (Fischer, p. 104). (3) The first known exothermic reaction among the elements. Nitrogen as an acid and base forming element (HNO_3, N, NH_3). (4) Nitric oxide in the metabolism of nitrite bacteria. A substitute for sunlight. (5) Oxidases as peroxides. Autoxidation through iron, phosphorus and manganese. (6) Hydrolysis as related to oxidases. The too often overlooked difference between organic and inorganic hydrolysis and hydrosynthesis. The union of an inorganic acid and base and the union of amino acids very significantly *unlike*. As *generally interpreted* the $\overset{+}{H}$ and $\overset{-}{HO}$ ions of the two cases are reversed from one another. (7) Nucleic acid as probably related to enzyme action. (8) The co-enzymes and specificity.

A New Form of Absorption Bottle for Use with either Calcium Chloride or Soda Lime in Organic Combustion: H. L. Fischer.

Spectrophotometric Study of Copper Complexes and Biuret Reaction: P. A. Kober and A. B. Haw.

The absorption spectra of the copper complexes of amino acids, peptides and proteins were studied quantitatively, by means of a Hilger sector photometer and a spectroscope.

The results—the nature and amount of absorption—are in harmony with the theory of biuret reaction of Kober and Segiura.

[2] Brit. Encyclop., New Edition, Vol. 3, p. 165; Lafar's "Tech. Mycol.," Vol. I., p. 380; Fischer's "Structure and Functions of Bacteria," p. 51.

The Constitution of the Three Nitro-α-carbopyrrolic Acids: W. J. HALE.

The Oxidation of Ethyl Alcohol with Alkaline Potassium Permanganate: W. L. EVANS AND J. E. DAY.

The Oxidation of Certain Lactates with Potassium Permanganate: W. L. EVANS, P. A. DAVIS AND P. COTTRINGER.

Condensation Products of Menthane formed by the Action of Aluminum Chloride: GEO. B. FRANKFORTER AND A. L. NEWMAN.

In view of the fact that aluminum chloride has been found to act as a condensation agent on the various hydrocarbons in the presence of oxygen compounds as aldehydes and ketones, it was tried on menthane, first in the presence of hydrocarbons, and later it was tried on menthane alone. In the former case benzene was used with menthane. A substance was formed which did not contain oxygen. Analysis indicated that it was a tetranuclear compound containing two molecules of menthane and two benzene radicals. A bromine derivative was prepared. A condensation product was made from menthane alone. Analysis indicated that it was likewise a tetranuclear substance containing four menthane radicles. Bromine compounds were also prepared. Nothing as yet has been learned of the molecular structure.

The Polymers of Pinene: G. B. AND C. J. FRANKFORTER.

Pinene tends to form complex resinous substances when treated with any of the halogen elements, as chlorine, bromine or iodine in addition to the formation of hydric salts. Not only do the elements themselves react with pinene, but also certain of their salts. Thus chlorine or aluminium chloride added cautiously to pinene forms resinous substances in addition to the hydrochloride and tarry matter. The resinous matter thus formed was found to be a complex substance. Two definite substances have been isolated and carefully studied, while a third doubtless exists. Analysis of the two which have been studied indicate the formula $(C_{10}H_{16})_2$ and $(C_{10}H_{16})_4$.

The Electron Conception of Valence. A Laboratory Search for Electromers: OLIVER KAMM.

The electron conception of valence as advocated by Falk, Nelson and others predicts three isomers in many cases where the theory of cis-trans isomerism demands only one or two. An extensive search was therefore made in order to isolate some of these missing isomers. It has, however, been possible to explain all of the results obtained on the basis of the atomic linking theory without using the electronic formulæ for the double union.

The Rearrangement of (N) Alkyl Anilines: C. G. DERICK AND J. W. HOWARD.

The action of heat upon methyl aniline was studied. No change was observed up to 500°. Similar results were obtained with dimethyl aniline.

The action of heat upon the methyl aniline hydrochloride has been thoroughly studied. Under temperature of 250° no shifting of the methyl group from the side chain nitrogen atom to the ring carbon atom was found. On the other hand, the percentages of the primary, secondary and tertiary amines was found to be constant within the temperature limits 200°–250°, the times of heating two to forty-eight hours, and the volume of the bomb tubes. No quaternary compounds were detected. The primary, secondary and Tertiary amines were proven to be aniline, monomethyl aniline and dimethyl aniline, respectively. At 300° the reaction is very different. The methyl radical shifts from the nitrogen atom to the carbon atom of the ring.

The Synthesis of 1-Phen-3-Phenoxy-Propane by the Grignard Reaction: C. G. DERICK AND L. O. POTTERF.

For the preparation of the 1-phen-3-phenoxypropane, phenyl magnesium bromide was prepared in the usual manner. The solvent ether was evaporated off on a water bath. The residue was dissolved in one and one half moles of phenetol and one mole of the 1-bromo-3-phenoxy-propane added. The solution was now heated slowly to the boiling-point under an air-condenser, when the last traces of ether were slowly driven off. This heating requires about an hour and is followed by three hours refluxing. The yield of the 1-phen-3-phenoxy-propane was 47 per cent., while if a few drops of dimethyl aniline were added the yield was increased to 61 per cent.

The Isomeric Tetracetates of Xylose and Observations regarding the Acetates of Melibiose, Trehalose and Sucrose: C. S. HUDSON AND J. M. JOHNSON.

The Preparation of Melibiose: C. S. HUDSON AND T. S. HARDING.

A Second Crystalline d-Fructose Pentacetate (α-d-Fructose Pentacetate): C. S. HUDSON AND D. H. BRAUNS.

Bromoacetylxylose and Beta Triacetylmethylxyloside: J. K. DALE.

An Undissociated Organic Acid in the Rôle of a Catalytic Agent: H. C. BIDDLE.

In the inversion of sugar and in the hydrolysis of esters in the presence of acids, the speed of the reaction is a direct function of the concentration of the hydrogen ions. In the conversion of cinchona alkaloids into their toxins, however, we are dealing with a catalysis in which the hydrogen ion acts as an inhibiting agent and the positive catalyst is the undissociated molecule of an organic acid.

The Isomerism of 1, 4, 5, 6, Tetrahydroxynaphthalene: A. S. Wheeler and V. C. Edwards.

Naphtazarin on reduction with stannous chloride and hydrochloric acid yields 1, 4, 5, 6, tetrahydroxynaphthalene, yellow, melting at 154°. It dissolves in alcohol, but deposits deep red crystals, also melting at 154°, which possess the same empirical formula and do not even differ in structure so far as the experiments of Zincke and Schmidt and ourselves indicate. We find, however, that the yellow compound, always considered a phenol, is also a ketone and must be included among the keto-enol compounds. We obtained excellent yields of ketone derivatives with semicarbazine, phenylsemicarbazine, and four other similar reagents. No oxime could be prepared on account of the sensitiveness of this phenol to basic reagents. According to whether we used one or two molecules of phenylsemicarbazine, we get a mono- or a diphenylsemicarbazone. Acetylation gives a high yield of a tetracetyl derivative. The isomers themselves we have been unable to separate.

The Bromination of 1, 4, 5, 6, Tetrahydroxynaphthalene: A. S. Wheeler and V. C. Edwards.

This phenol is readily brominated, best in glacial acetic acid solution, a dibromdihydroxyquinone being formed. If the bromination is carried out in hot acetic acid, the product contains two less H atoms. These products are very slowly acetylated with acetyl chloride and this made the starting-point of two series of derivatives whose character can not be indicated in a short abstract. Naphtazarine was also brominated and yielded a series of derivatives which assisted in determining the structure of members of the above series.

Simple and Mixed Alkyl Phosphates: W. A. Drushel.

1. The alkyl phosphates are very stable at room temperature in $N/10$ HCl, but are rapidly saponified by barium hydroxide.

2. All alkyl groups are hydrolyzable, the first more easily than the second and third.

3. In mixed alkyl phosphates one alkyl group is not hydrolysed to the exclusion of the other, contrary to Lossen and Köhler's theory.

4. These esters are distillable in vacuo without decomposition.

On the Preparation and Properties of Hydracrylic Esters: W. A. Drushel and W. H. T. Holden.

Hydracrylic acid is obtained from glycerine through B-iodopropionic acid by the removal of hydriodic acid from the latter by silver oxide. It is easily esterified with common alcohols in the absence of mineral acids by using anhydrous copper sulphate. The yields of esters are from 80 per cent. to 90 per cent.

The hydracrylic esters are all colorless, with a faint but characteristic odor, mostly readily soluble in water, all below isoamyl hydracryate are heavier than water and all boil with decomposition at atmospheric pressure but are distillable under diminished pressure without decomposition.

On the Synthesis of Glycocoll and Diethyl Carbonate: W. A. Drushel and D. R. Knapp.

A modification of the method of Kraut for the preparation of glycocoll. The yield is the same as that obtained by Kraut (55 per cent.).

Nef's method for the preparation of diethyl carbonate is modified. Diethyl carbonate boils at 127°. The specific gravity at 25° is 0.968 and the saponification equivalent is 59.

Further Studies upon the Resene of Pinus Heteropylla: Chas. H. Herty and V. A. Coulter.

The Occurrence of Inosite Triphosphoric Acid in Cottonseed Meal: J. B. Rather.

An inosite phosphoric acid corresponding in composition to inosite triphosphoric acid, $C_6H_6(OH)_3(H_2PO_4)_3$, has been separated from cottonseed meal by means of its crystallin strychnin salt. This confirms the previous work of the author on the composition of the acid in so far as it indicates that cottonseed meal contains an inosite-phosphoric acid much richer in carbon and poorer in phosphorus than the so-called phytic acid $C_2H_8P_2O_9$. These results are not in accord with the view that the principal inosite phosphoric acid of cottonseed meal is inosite hexaphosphoric acid $C_6H_6(H_2PO_4)_6$, although it is possible that the present acid is a hydrolytic product of that substance.

Baly's Theory of Chemical Reactions: W. M. Dehn.

Study of the Common Bean: W. M. Dehn.

A Case of Steric Hindrance in Enzymes: W. M. Dehn.

Colorimetric Studies of Picrate Solutions: W. M. Dehn.

Certain Non-interchangeable Radicals: W. M. Dehn.

Charles L. Parsons,
Secretary

Date of issue.	Date of issue.	Date of issue.